Enter'd in the Hall Book.

B. Cole, sculp.

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B. Cole sculp.

THE
ART of SOUND BUILDING,

Demonstrated in

Geometrical PROBLEMS:

SHEWING

Geometrical LINES

For all KINDS of

Arches, Niches, Groins, and *Twisted Rails,*
both Regular and Irregular.

With several other

DRAUGHTS of Buildings and Staircases.

ALL

Curiously Engraven on COPPER PLATES.

Wherein are laid down (suited to every Capacity) easy Practical
METHODS for *Carpenters, Joiners, Masons,* or *Bricklayers,*
to work by.

By WILLIAM HALFPENNY,
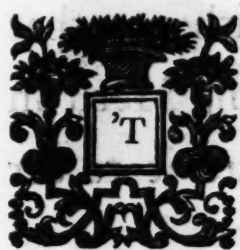
Architect and Carpenter.

To the Honourable

Sir *ANDREW FOUNTAIN*, Knt.

S I R,

'T IS with Pleasure I lay the following Piece at your Feet, as being convinc'd I do it to one who is an absolute Judge of the Merits thereof. You, Sir, are perfectly senfible of the Neceffity and Ufefulness of a Work of this Kind, and will readily perceive the Induftry and Pains ufed in the Compiling of this. Your Tafte, Sir, will eafily point out to you what is good in it, and what deficient; and your Humanity will lead you to countenance and recommend the one, as your Love to the Art will move you to correct the other. In Effect, Sir, if I make my Addrefs to you, 'tis lefs as a Patron than as a Judge: Your

[b]   Cenfure

DEDICATION.

Cenſure I ſtand in more Awe of than that of the Publick; as I reckon 'tis that will determine this.

An uncommon Penetration, an exquiſite Judgment, a delicate Taſte, and a thorough Acquaintance with the Subject of a Book, are Qualities much to be feared by a Dedicator: And I will add, they are Qualities it had been ſo eaſy to have found a Patron without, that it ought to be a Preſumption of ſome Merit in the Work, that I dare to dedicate it to Sir *Andrew Fountain*.

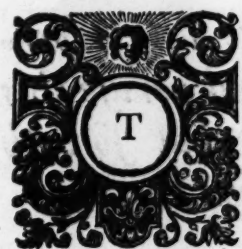*I am, SIR,*

With entire Submiſſion,

Your Humble Servant,

WILLIAM HALFPENNY.

THE

THE
PREFACE.

THE *Reasons that first induced me to publish this Work, was the daily Errors that I saw Workmen commit in framing their Works for Buildings, on account of their Want of the Knowledge of the Proportions contain'd in this Book, being the only Thing, that I know of, that is wanting to make the Art of Building compleat.*

HERE *I would not be thought to be so vain, as to teach our Architects; neither do I believe they are insensible of the Usefulness of this, or much greater Works; but rather blame them for keeping so advantageous a Work from the Eyes of the World.*

IT *is certainly every Man's Duty to reveal whatever he thinks may be of Service to the Publick; and so I have shewn the Nature of all Kinds of Arches in this Work, and laid down easy and practicable Ways of drawing and working of them,*

The PREFACE.

so that any Workman, with a little Pains, may understand the Nature, true Butments, and Intersections of all Kinds of Arches, from whence he may strengthen and very much beautify them, especially Irregular Groins, which have been made very ill, for want of knowing, when the Arch of either Spand being given, what must be the Arch of the other, so that the Intersection of them shall beget the Groin to stand perpendicularly over its Base.

THEREFORE *I earnestly desire all Workmen to lay aside erroneous Methods, and peruse this short Track of mine, or some other, that so both they and their Art may get Reputation thereby.*

I HAVE *thought fit to say thus much by way of Preface; and as for the rest let the Work answer.*

WILLIAM HALFPENNY.

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This Church is of my Invention for Leeds in Yorkshire.

THE
ART of SOUND BUILDING.

SECTION I.

Of the Description of ARCHES *by the Intersection of Lines,* &c.

PROBLEM I.

How to erect a Perpendicular from the Middle of a Right-Line given.

PLATE I. FIGURE I.

The given Right-Line is A B, *and* C *is the middle Point thereof ; Upon which it is required to erect the Perpendicular.*

FIRST open your Compasses at Pleasure to any Distance, greater than half the Line, and setting one Foot in the Point A, with the other sweep the Arch *e e*; this being done, with the same Opening of your Compasses set one Foot in B, and with the other sweep the Arch *d d*. Then from the Point where these two Arches cut one another, draw a Right-Line to the Point C, and that Line will be perpendicular to the given Line A B.

PRO.

PROBLEM II.

How to erect a Perpendicular from the End of a Right-Line given.

FIGURE II.

Let the given Right-Line be AB, *and* B *the End from which it is required to erect a Perpendicular.*

FIRST open your Compasses to any convenient Distance, and setting one Foot in B, mark that Distance five Times in the Line A B from B to C, so that B C be divided into five equal Parts. Then taking four of those Divisions in your Compasses, as from D to B, set one Foot upon the End of the Line B, and strike the Arch *d d*; and afterwards opening the Compasses to the Distance of five of those Parts, or the Length C B, set one Foot in E, the End of the third of the equal Parts from B, and with the other strike the Arch *e e*. This being done, if a Line be drawn from the Point where the two Arches cut one another to the Point B, that will be a perpendicular to A B.

PROBLEM III.

How to describe a Scheme-Arch, when the Length of the Base and Perpendicular are given.

FIGURE III.

Let the Length of the Base A B *be five Foot, and let the Perpendicular* C E *be one Foot: The Arch* A C B *is required to be drawn.*

FIRST draw the Base A B five Foot, and halve it at E, and from E raise the Perpendicular E C of one Foot in Height; then lay a streight Rule on the two Points C and E, and draw a Line at Pleasure from

E

E towards G. This being done, draw the Hypothenuſal Line C B, and halve it at D; and taking the Length of this Line C B, either with a Line, or Beam Compaſs, or common Compaſs, (if they will open wide enough,) from the Point B ſweep the Arch *i i*, and from the Point C, the Arch *h h*; then from D, thro' the Interſection of the two Arches, draw a Line to cut the Line C G at F, and F will be the Center of the Arch; to be drawn about which, you may deſcribe the ſought Arch A C B with the Diſtance F C.

PROBLEM IV.

How to draw a Scheme-Arch, without finding the Center thereof, the Baſe and Perpendicular being given.

FIGURE IV.

Let the Baſe A B be five Foot, and the Perpendicular E D be one Foot, the Arch A D B is required.

FIRST draw the Baſe A B five Foot in Length, and halve it at E, and on E raiſe the Perpendicular E D, equal to one Foot, the Height of the Arch, and continue it to C, ſo that C D be likewiſe one Foot; and from the Point C to the Points A and B, draw the Lines C A and C B. This being done, divide each of them into an equal Number of equal Parts at Pleaſure, (the greater the Number is, the exacter will the Work be,) one of which, in this Example may be about two Inches; then if ſtraight Lines are drawn from the Points of Diviſion, 1, 2, 3, &c. of the Line A C to the Correſpondent Points of Diviſion 1, 2, 3, &c. of the Line C B, the Points wherein every two of theſe Correſpondent Lines cut one another, will be in the Arch required; and ſo the Arch A D B will be made by drawing theſe Lines, equal to the Arch A C B, of *Figure* III.

PROBLEM V.
How to draw a rampant-Scheme Arch.

FIGURE V.

FIRST draw the prick'd Line A B, to reprefent the Width of the Door, or Window, upon which the Arch is to ftand, and halve it at G, and from the Point B raife a Perpendicular B C, equal to the Ramp of the Arch, and draw the Bafe Line A C; then from G raife a Perpendicular to A E, which will cut the Bafe A C in half in F, and continue it to D, fo that F D be equal to twice the Heighth the Arch is to rife, that is, twice F E. Having done this, from the Point D to the Points A and C, draw the Lines D A and D C, each of which divide into an equal Number of equal Parts at Pleafure, as 1, 2, 3, 4, *&c.* 1, 2, 3, 4, *&c.* which may be each about two Inches: If A B be four Foot, and F E one Foot; then if ftreight Lines are drawn from the Points of Divifion, 1, 2, 3, 4, *&c.* of the Line A D, to the correfpondent Points 1, 2, 3, 4, *&c.* of Divifion of the Line C D, the Points wherein every two of thefe correfpondent Lines cut one another, will be in the Arch required; and fo the Rampant Scheme-Arch A E C will be made, which was required.

Note, When the Point C is the fame as B, or when it comes down to B, then will the Arch AEC be equal, and like to thofe of *Figure* III. and *Figure* IV.

PROBLEM VI.
How to defcribe a Semicircular Arch by the Inter-fection of Streight Lines.

FIGURE VI.

FIRST draw the Bafe Line A B, and halve it at C, and at the Point C raife the Perpendicular C G, equal in Length to C A, or C B; then divide the Semidia-

meter

meter A C into seven equal Parts, and continue it out to
D; so that A D be two of those Parts. This being done,
take C D in your Compasses, and setting one Foot in C,
with the other strike the Arch D F, of a Length at Plea-
sure; then with your Compasses, open'd to any convenient
Distance, from A and G sweep the Arches *k* and *e*, and
through their Intersection, and the Point C draw a straight
Line, cutting the Arch D F in the Point E, and draw the
Lines A E and E G. Again, take A E, or E G, in your Com-
passes, and from the Points B and G strike the Arches *i* and *h*,
and from the Intersection of these two Arches draw Lines
to G and B; and if the four equal Lines last drawn be
each divided into the same Number of equal Parts, and
correspondent intersecting Lines are drawn, according to
the Directions of the two last Problems, they will describe
the semicircular Scheme-Arch A G B required.

PROBLEM VII.

How to draw a Rampant Semicircular Arch.

FIGURE VII.

FIRST draw the Lines A G and G I, and I *l* and
B *l*, all equal to one another, after the very same
Manner as the Lines A E and E G, and G *h* and B *i*, all
equal to one another, are drawn in *Figure* VI. and also
draw the Arch E H at Pleasure here, as you did the Arch
D F there, and the Line G D here, as the Line E C there.
Then from the Point B raise the Perpendicular B C, repre-
senting the Heighth of the Ramp, and draw the Base
Line A C, which will be halved by the Perpendicular D I
in the Point F. This being done, continue the Perpendi-
cular D I to K, so that F K be equal to D I, that is, take
D I in your Compasses, and set it from F to K, and draw the
Lines A G and G K ; then take G K in your Compasses ;
and setting one Foot in K, with the other strike the
Arch *m*; also take the Length A G between your
Compasses, and with one Foot in C sweep the Arch *n*,
and from the Point of Intersection of these two Arches

C   draw

draw Lines to K and C, and divide the four out Lines laſt drawn, each into the ſame Number of equal Parts, and draw the interſecting Lines according to the Directions above given, and they will deſcribe the ſought Arch A K C.

PROBLEM VIII.

How to draw an Elliptick Arch to any Width and Heighth, when the Heighth is greater than the Width, by the Interſection of ſtraight Lines.

FIGURE VIII.

FIRST draw the Baſe Line A B, and raiſe the Lines A C and B D, Perpendicular to the ſame, and each equal to your deſigned Heighth, and draw the Line C D, which halve in the Point E. This being done, divide the Lines A C and E C, and E D and D B, each unto the ſame Number of equal Parts, and draw interſecting Lines according to the Directions above given, and you will have the Arch required A E B.

The End of PLATE I.

PROBLEM IX.

How to deſcribe an Elliptick Arch to any Width and Heighth, when the Heighth is leſs than the Width, by the Interſection of Lines.

FIGURE IX.

FIRST draw the Baſe Line A B, and from the Ends, A and B, thereof raiſe the Perpendicular A C and B E, each equal to your deſigned Heighth, and draw the Line
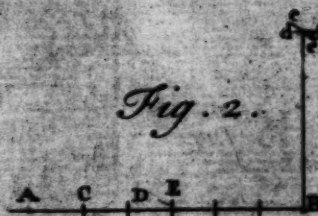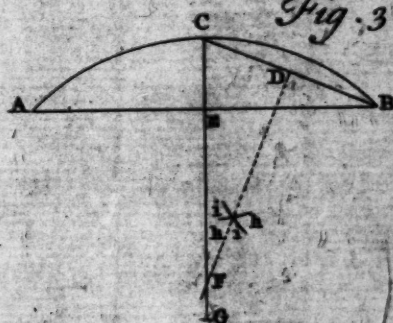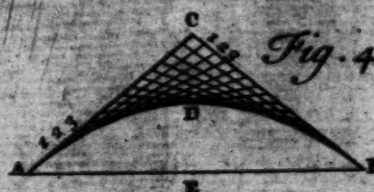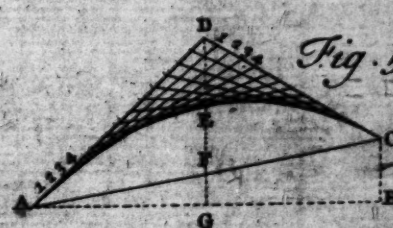
Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.
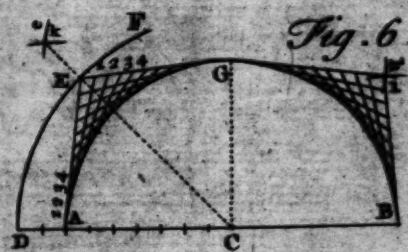
Fig. 7.
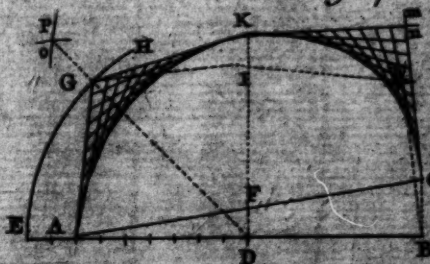
Fig. 8.
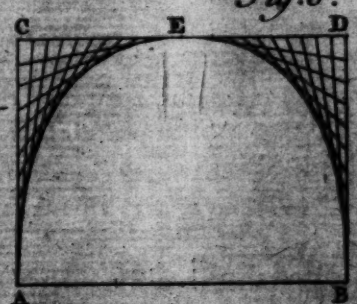
Plate 4.

Line CD, which halve in the Point E. This being done, divide the Lines A C and C D, and DE and EB, each into the same Number of equal Parts, and draw the intersecting Lines according to the Directions above given, and you will have the Arch A D B required.

PROBLEM X.

How to draw an Elliptick Arch by Means of a Tramel.

FIGURE X.

FIRST make the Tramel A B C *i* in the same Form as it is represented in the Figure, where the Leg C *i* is at Right-Angles to the Head A B, both of which have Grooves in the Middles of them for the Pins *e* and *f*, which are fastened to the Rule or Lath D H, of a Length greater than *i* B, the half of the Base of the Arch to slide in. Then if the wooden Pins *e* and *f* are fix'd in the Lath at such a Distance from one another, that when a Pencil, or any Thing else proper to make a Mark with, is put through a Hole *g*, made in the same with a small Gimblet, the Length *e g* is equal to *i* B, the Half of the Base Line of the Arch, and the Length *f g* equal to the Heighth the Arch is to arise, and the Tramel be fix'd fast in the Place, you Design to strike the Arch upon, and the Pencil *g* be put in the Point A, and the Pins *f* and *e* in the Grooves A B and *i c*, and with one Hand you move the Pencil *g*, and with the other guide the Pins *e* and *f* in their respective Grooves, when the Pencil is come to A, it will describe the Elliptick Arch A H B required.

PRO-

PROBLEM XI.

To draw a Rampant Elliptick Arch by the Intersection of straight Lines.

FIGURE XI.

FIRST draw the prick'd Right-Line A B, and from B erect the Perpendicular B E equal in Length to the Heighth of the Ramp, and continue it out to H, so that E H be equal to the Heighth of the Arch, and draw the Line A E. Also at the Point A draw A F Perpendicular to A B, and equal to E H, or the Heighth of the Arch, and from the Points F and H draw the Line F H, which halve in G. This being done, divide the four Out-lines A F and F G, and G H and H E, each into the same Number of equal Parts, and draw the intersecting Lines as above directed, and you will have the Arch A G E, which was required to be drawn.

PROBLEM XII.

To draw a Gothick Arch, or Oxi, when the Heighth is greater than the Width, by the Intersection of straight Lines.

FIGURE XII.

FIRST draw the Base Line A B, and halve it at C, from which erect a Perpendicular of a Length, at Pleasure, and in it set of the Heighth of the Arch C F, and at the Points A and B raise the Perpendiculars A D and B E, each equal in Length to half the Heighth C F, and draw the Lines F D and F E. This being done, divide the four Out-lines A D and D F, and F E and E B, each into the same Number of equal Parts, and draw the intersecting Lines as before directed, and they will make the Arch A F B, which was required to be drawn.

<div align="right">PRO-</div>

PROBLEM XIII.

To draw a Gothick Arch, or Oxi, when the Heighth is less than the Width by the Intersection of straight Lines.

FIGURE XIII.

FIRST draw the Base Line A B, and halve it at C, from which erect a Perpendicular of a Length at Pleasure, and in it set off the Heighth of the Arch C E, and at the Points A and B raise the Perpendiculars A D and B F, each equal in Length to half the Heighth C E, and draw the Lines D E and F E. This being done, divide these four Out-Lines A D and D E, and E F and F B, each into the same Number of equal Parts, and draw the Intersecting Lines as before directed; and they will form or make the Arch A E B, which was required to be drawn.

Note, If the Arch is required to be quicker or flatter on the Hanse, it is but lengthening, or shortening the Perpendicular Lines A D and B F.

PROBLEM XIV.

To draw a Rampant Gothick Arch, or Oxi, by the Intersection of Lines.

FIGURE XIV.

FIRST draw the prick'd Line A B, and halve it at C, and from B raise the Perpendicular B E, equal in Length to the Heighth of the Ramp, and draw the Line A E, and from C draw C G perpendicular to A B, in which take D G equal to the Heighth of the Arch. Then at the Point A raise the Line A F perpendicular to A B, and equal to one Half of the Heighth of the Arch, and continue B E to H, so that E H be also equal

D　　　　　　　　　　　　　to

to half that Heighth, and draw the Lines F G and G H. This being done, divide thefe four Lines A F and F G, and G H and H E, each into the fame Number of equal Parts, and draw the Interfecting Lines as before directed, and they will form or make the Arch A E B, which was required to be drawn.

PROBLEM XV.

To ftrike or draw Gothick Arches by Means of other Arches.

FIGURE XV.

FIRST draw the Bafe Line A B, and fet off the Thicknefs of the Arch from A to C, and from B to O, and divide C O into three equal Parts in the Points D and E, about whcih defcribe two Half-Circles C *i* E and D *n* O. Then taking C O, or D O, each of which is two Thirds of C O, between your Compaffes, and fetting one Foot in C, with the other fweep the Arch E F, and the Compaffes remaining open'd to the fame Diftance, fet one Foot in E, and fweep the Arch C F. And in like Manner fweep the Arches D G and O G, from the Centres O and D, and from the Interfection of the two Arches at F, through the Centre E, draw the ftraight Line F M, and from the Interfection of the two Arches at G, thro' the Centre D, draw the ftraight Line G H. The Centres D, E, F, and G, being thus found, take A D in your Compaffes, and fetting one Foot in D, with the other ftrike the Arch A H, in like Manner, with the fame Diftance, and one Foot in E, draw the Arch B M. This being done, take F *n* between your Compaffes, and fetting one Foot in G, ftrike the Arches *i* K, and H L, and alfo with the fame Diftance, and one Foot in F, defcribe the Arches *n* K and L M, and the required Arch C A L B O is drawn.

PRO-

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

Plate 2.
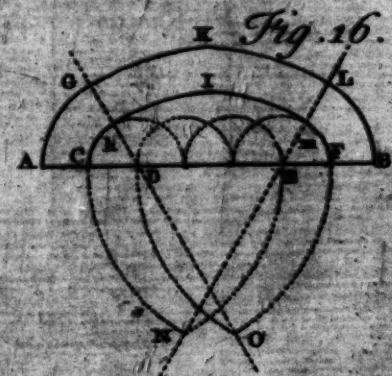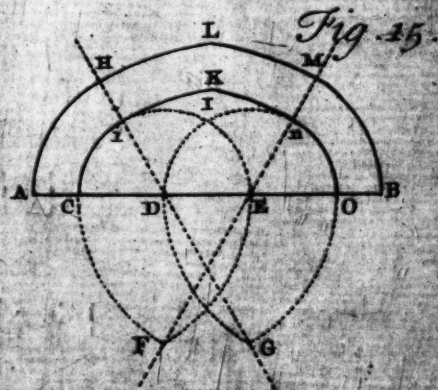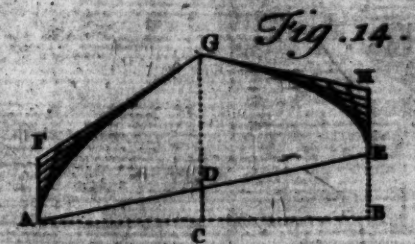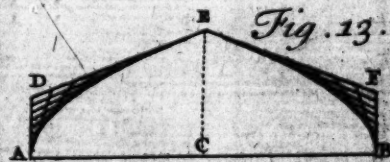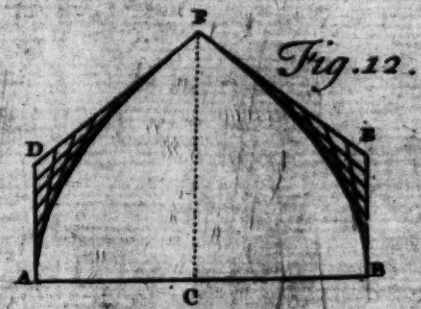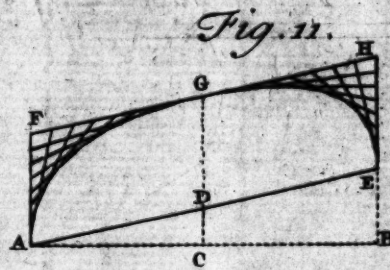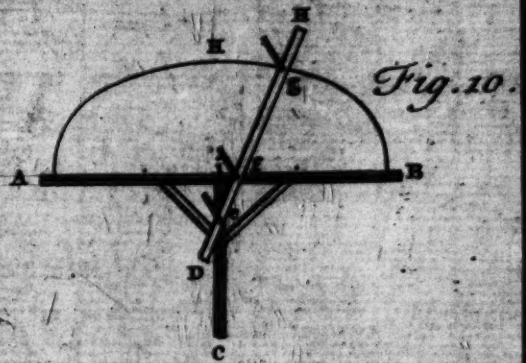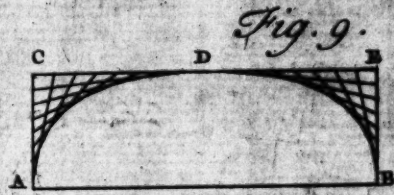
PROBLEM XVI.

To defcribe or draw a Gothick Arch of another Kind by Means of Circular Arches.

FIGURE XVI.

FIRST draw the Bafe Line A B, and fet off the Thicknefs of the Arch from A to C, and from B to F, and divide C F into five equal Parts, upon which defcribe four equal Half-Circles, D and E being the Centers of the outermoft ones. This being done, extend your Compaffes from F to D, or from C to E, and fetting one Foot in F, with the other ftrike the Arch D O. The Compaffes remaining thus open'd, fet one Foot in D, and with the other draw the Arch O F. In like Manner, upon the Centers F and E with the fame Diftance, draw the two Arches C N and D O. Then from the Interfections N and O of thefe two Arches, through the Centers E and D of the outermoft Half-Circles, draw the ftraight Lines N L and O G of Lengths at Pleafure, and on the Centers E and D, with the Diftance E B, or A D, between your Compaffes, ftrike the Arches B L and A G. Moreover, extend your Compaffes from O to O *h*, or from N to *m*, and with one Foot in O, draw the Arch *h* I, and with one Foot in N, the Arch *m* I. Laftly, take the Diftance O G, or N L, in your Compaffes, and on the Centers O and N draw the Arches G K and K L, and the Arch C A K B F will be finifhed.

The End of PLATE II.

PROBLEM XVII.

To draw a Shipwright's Arch, by the Interſection of ſtraight Lines.

FIGURE XVII.

FIRST draw AB, the Baſe Line, and from A and B, the Ends thereof, erect the Perpendiculars AC and BE, whoſe Difference in Length or Heighth muſt anſwer to the Rake of the Arch, or Ceiling of the Cabin, and draw the Line CE, which halve in the Point D. This being done, divide AC and CD, and BE and ED, each into the ſame Number of equal Parts, and draw the Interſecting Lines as is taught in the foregoing Problems, and they will form or make the required Arch ADB.

PROBLEM XVIII.

To draw a Bow-Arch by the Interſection of ſtraight Lines.

FIGURE XVIII.

FIRST draw the Baſe Line AB, and halve it C: Then draw the Line GH of a Length at Pleaſure, parallel to AB, or perpendicular to CE, (which is a Perpendicular to AB, drawn from the Middle Point C,) and at a Diſtance from it, equal to the Heighth of the Arch, and draw the Lines AD and BF. Then take CE in your Compaſſes, and ſet it off from E to D, and from E to F, and draw the Lines AD and BF. This being done, divide the Lines AD and DE, and BF and EF, each into the ſame Number of equal Parts, and draw the Interſecting Lines as is taught in foregoing Problems, and they will form or make the required Arch AEB.

Note,

Note, The aforesaid Arch is very necessary to be used in wide Spands, or Spaces, where there is not Conveniency to raise a Semicircular Arch, as in Vaults under Streets, or Arches of Bridges, where great Strength is required; because the Butments of this Bow-Arch are much stronger than those of Gothick Arches, Elliptick ones, or any Scheme or Semicircular Arches.

PROBLEM XIX.
To draw the two different Edges of a Twisted Schofeet.

FIGURE XIX.

THE nineteenth Figure represents the inward and outward Edges of a twisting Schofeet of a Semicircular Door, or Window, whose Jaums, from the Beginning to the Springing of the Arch, splays more or less, according to the Humour of the Builder, and whose Crown lies level without splaying, the outward Arch CFD being even with the Head of the Window-Case. Now the Question is, how to find the inward Edge AFB, so that it shall diminish gradually from nothing at the Crown F, to the Splay of the Jaums at the Springing AC and DB.

FIRST draw the Base Line AB equal to the Width of the Window and Splays of both Jaums, and halve it at H, and from it raise the Perpendicular HF to AB, and set the Splays inwardly from A to C, and from B to D. This being done, extend your Compasses from H to D, or from H to C; and setting one Foot in H, with the other strike the Semicircle CFD, and draw the Line IK of a Length at Pleasure, parallel to the Base Line, and at a Distance from it, equal to the Heighth of the Arch CFD; and take the Height HF between your Compasses, and lay off that Heighth from F to E, and from F to G in the Line IK, and draw the Lines AE and BG. Lastly, divide the Lines AE and EF, and BG and FG, each into the same Number of equal Parts, and draw the Intersecting Lines as is

E   taught

taught the foregoing Problems, and they will form or make the Arch A F B, which will splay gradually from nothing at F to A C and D B, which is what was required to be done.

SECTION II.

Of GROINS.

PROBLEM. XX.

To find the Angle, or Mitre-Bracket of a Cove.

FIGURE XX.

FIRST draw the Base A B of the regular Bracket, and from A draw A D, perpendicular and equal to it, and draw the Line D B, and continue the Line D A to C, so that A C be also equal to A B; then extending your Compasses from A to B, and setting one Foot in A, with the other describe the Arch, or Quarter of a Circle C B, and from the Point D draw D F, perpendicular to D B, and equal to D A, or A C, and another as B E from B, likewise equal to D A, and draw the Line F E, which will be parallel to D B. This being done, divide A B into a Number of equal Parts, not exceeding two Inches and an half, and thro' the Divisions of them draw Lines parallel to A C, to touch the Arch C B, which continue out to the Line D B, and this Line will be divided likewise into the same Number of equal Parts, as A B is. Lastly, from the Divisions of the Line D B, draw Lines Parallel to D F, and in each of them, from D B, lay off its Respection Parallel, (from A B to the Arch B C,) and at the Points whereat they end stick small Nails, or Pins, and take a thin Lath, and bend

it

it round the Nails, or Pins, obſerving that it touches them all, and with a Pencil, or any Thing elſe, proper to make a Mark, deſcribe the Arch F B round the Edges of the Lath; and this is the Arch for the Angle, or Mitre-Bracket.

PROBLEM XXI.

To find the Angle, or Mitre-Arch of a Regular Groin, when the Interſecting Arches are Semi-circles.

FIGURE XXI.

FIRST draw the Line A B, and from the Ends A and B thereof, let fall the Perpendiculars A C and B D to it, and each of the ſame Length as it, and draw the Line C D; then halve the Line A B in *e*, and with the Diſtance A *e*, or *e* B, about the Center *e*, deſcribe the Semicircle A F B, and draw the Line A D. This being done, at the Points A and D raiſe the Lines A G and D A perpendicular to A B, each equal in Length to the Heighth of the Semicircle *e* F, and draw the Line G H. Laſtly, divide the Line A B into any Number of equal Parts, thro' the Diviſions of which draw Lines to touch the Semicircle A F B, parallel to B D, and to divide the ſtraight Line A B; then if Parallels to A G are drawn from the Diviſions of A D, and in each of them from A D, is ſet off its Correſpondent Parallel, (from A B to the Arch A F B,) and at the Points whereat they end be ſtuck in Nails, and a thin Rule be bent round them, ſo as to touch them all, a Pencil, or other Thing proper to make a Mark, being mov'd round the Edge of the Rule, will deſcribe the Arch A *i* D, which is the Angle, or Mitre-Arch of a Regular Groin.

PRO-

PROBLEM XXII.

To find the Angle, or Mitre-Arch of a Regular Groin, when the Interfecting Arches are Gothick ones, viz. fuch as are fhewn how to be drawn in Figure xv.

FIGURE XXII.

FIRST draw the Lines A B, BD, DC, A C, and A D, in the Manner as was fhewn in the laft Problem, and upon A B and B D defcribe the Gothick Arches A F B and B L D, according to the Directions laid down in *Problem* xv. Then divide the Line A B into any Number of equal Parts, and from the Divifions thereof draw Parallels to BD to touch or come to the Arch A F B, and divide the Line A D, and at the Points A and D raife the Perpendiculars A G and GH, each equal to F *e*, and draw the Line G H. Then draw Parallels to A G from the Divifions of A D, and in each of them from A D fet off its Correfpondent parallel, (from A B to the Arch A F B,) and at the Points whereat they end, ftick in Nails. This being done, if a thin Rule be bent round them, fo as to touch them all, and a Pencil, or other Thing proper to mark with, be moved round the Edge of the Rule, the Mitre-Arch A *i* D will by this Means be defcribed.

Note, In this Figure, and all others, whofe Hanfes rife quick, after you have made the equal Divifions, and drawn the Parallels according to the foregoing Rules, before you defcribe the Arch fought, divide the firft and fecond Divifion next to the fpringing Foot of every Arch, each into two equal Parts, from whence draw other Parallels as is before taught, and fet off their Heighths or Lengths in the other Parallels; and by this Means your Hanfe will have its true Bearing, and not be crippled.

PROBLEM XXIII.

If the leſſer Arch of an Irregular Groin be a given Semicircle, it is required to form a larger one, (not a Semicircle,) ſo that the Interſection of thoſe two Arches ſhall beget, or make the Arch-Line of the Angle to hang pependicular over its Baſe; as alſo to draw that Arch-Line of the Angle.

FIGURE XXIII.

FIRST draw the Lines AB and CD, to repreſent the Walls from whence the Arches ſpring, and draw the Line CB, and on the Line AC deſcribe the Semicircle AEC, and divide AC into any Number of equal Parts, from whence draw Parallel Lines to CD, to touch or come to the Arch AEC, and if thoſe Parallels are continued out to the Line CB, they will divide it into the ſame Number of equal Parts, as AC is; and if from each of the Diviſions of this laſt Line Parallels to AC are drawn, they will divide the Line AB into the ſame Number of equal Parts, as AC, or CB, is divided into. This being done, continue AC to I, ſo that AI be equal to E*f*, and continue DB to K, ſo that KB be likewiſe equal to E*f*, or AI, and draw the Line IK. Moreover, at the Points C and B raiſe the Perpendiculars CN and BO to CB, each of the ſame Length as E*f*, or AI, or BK, and draw the Line NO. Laſtly, from the Diviſions of AB, draw Parallels to AI, (that is, continue the Parallels drawn from the Diviſions of the Line CB to the Line IK,) and from the Diviſions of CB Parallels to CN. Then ſet of the Heighths or Lengths of each of the Parallels in the Semicircle AEC, upon the Correſpondent Parallels to AI and CN, and ſtick in Nails whereat they terminate; and if a Lath be bent round them, ſo as to touch them all, and a Pencil be moved round the Edge of it, the Arches AHB and BMI will be found; which was required to be done.

F   *Note,*

Note; The Prick'd Lines in this, and all other Examples
of this Kind, shew that one Parallel Line has a Relation
with the other. For Example: The Lines *f* E, *g h*, and
l M, are all equal to one another; so that if the three
Arches A H B, A E C, and C M B, were raised perpendicu-
larly upon the Lines A B, A C, and C B, and a Line
drawn from H to M, and another from M to E; then
would the Line H M be parallel to, and directly over the
prick'd Line *b g*. In like Manner, the Line E M would be
parallel to, and directly over the prick'd Line *f b*. Under-
stand the same of the other Parallels and prick'd Lines in
this Figure, and any others of the like Nature.

PROBLEM XXIV.

If the lesser Arch of an Irregular Groin be a Scheme-
Arch, it is required to form the greater, (which
will not be Circular,) so that the Intersection of
these two Arches shall beget the Arch-Line of
the Angle to hang perpendicularly over its Base,
and to draw this Arch-Line of the Angle.

FIGURE XXIV.

FIRST draw the Lines A B and C D, to represent the Walls
from whence the Arches spring, and upon B D describe
the given Scheme-Arch B H D, and divide B D into any
Number of equal Parts, thro' the Divisions of which you
must draw Parallels to the Arch, as above; and when the
Line A D is drawn, continue those Parallels to it, and
they will divide it into the same Number of equal Parts
as A B is; and from each of these last Divisions draw Paral-
lels to divide the Line A B into the same Number of equal
Parts as B D, or A D, is divided into. This being done, at
the Point A draw the Lines A L and A N perpendicular to
A B and A D, each of the same Length as *g* H; and from
the Points B and D, the Lines B M and D O, and draw the
Lines L M and N O. Lastly, if Parallels are drawn from
the

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

Plate 3.
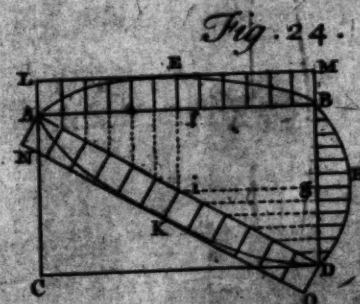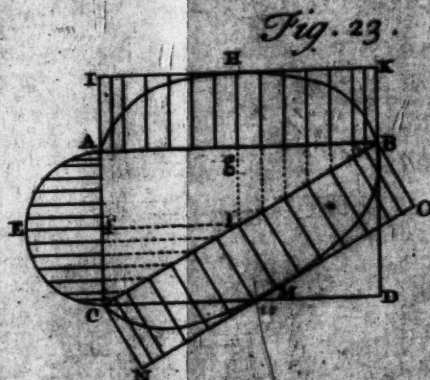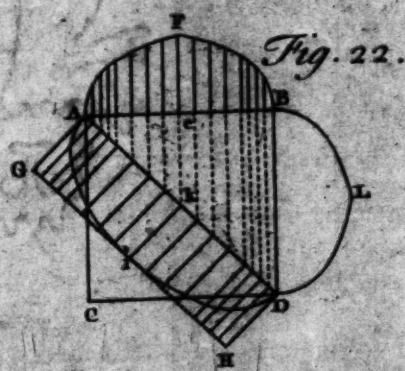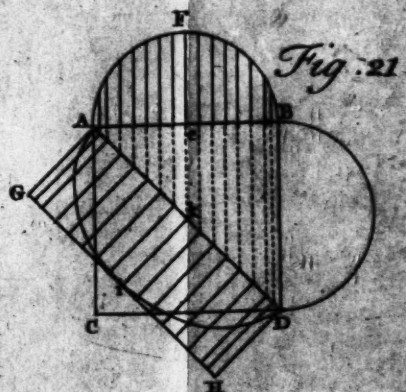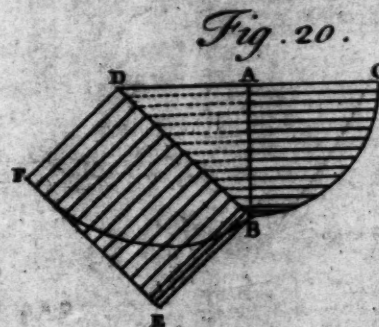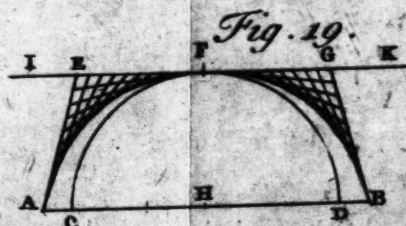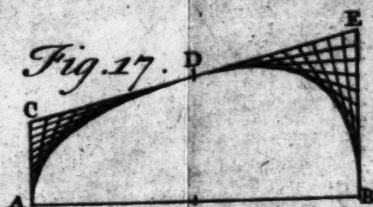
the Divisions of A B and A D, after the very same Way as in the last Problem, and you lay off upon them the Parallels in the Scheme-Arch B H D, and proceed according to the Directions above, you will form the Arches A E B and A K D, required.

Note, You need not make use of the Diagonal Arch A K D, in the making of the Centres for Bricklayers or Masons to turn their Arches upon; because the two Arches A E B and B H D do intersect each other, and make the Angle or Edge of the Groin hang perpendicularly over its Base; and therefore the Use thereof is only in the framing of Ceilings, or the like, being in the Nature of a Hip or Valley.

The End of PLATE III.

PROBLEM XXV.

Having one Centre given for an unequal-sided Groin, to form the other, so that the Intersection thereof shall produce the Angle, or Mitre-Arch, to hang perpendicularly over its Base: And, moreover, to draw the Curve thereof.

FIGURE XXV.

DRAW the Lines A B and B D, and D C and C A, each equal to one another, to represent the Walls from whence the Arches spring, and on the Line A B describe the given Arch A F B. This being done, divide the Line A B into any Number of equal Parts, from whence raise Perpendiculars to A B to touch the Arch A F B, and draw the Diagonal Lines A D and C B. Then take the Line E F, and set it perpendicular to the Lines A C, A D, C D, C B, B D, from A to O, from A to I, from C to P, from C to S, from C to L, from D to K, from D to T, from D to V, and from B to M, and from B to Z, and draw the straight Lines O P, I K, S T, L M, and Z V.

Now

Now divide the Bafe Lines B D, D C, C A, A D, and B C, each into the fame Number of equal Parts as A B is divided into, and from the Points of Divifion draw Parallel Lines to touch the Lines O P, S T, V Z, C M, and I K. Then take the Lengths of the Perpendiculars to A B, drawn to touch the given Arch A F B, and fet them off in the correfpondent Parallels, drawn from the Points of Divifion of the feveral Bafes upwards, and the Arches B*y*D, D*v*C, C*q*A, A*b*D, and C*n*B, will be defcribed as in the foregoing Examples, (*Figure* XXIII, *&* XXIV.) whofe Heighths *x y*, *w v*, *r q*, *g h*, and *g n*, are each equal to E F, as likewife all the other correfpondent Heighths, from the Bafes, to the Curves that are formed.

PROBLEM XXVI.

The Arch-Line of a large Ceiling, or Vault, fuppofed to be Semicircular being given : How to form the Curve of a lefer Arch, that fhall interfect the Side thereof, to give way for Doors or Windows, fo that their Interfection fhall produce the Groin to hang perpendicularly over its Bafe ; as alfo to form the Curve-Line thereof.

FIGURE XXVI.

FIRST draw the Lines A B, B D, D C, and C A, to reprefent the Walls from whence the Arches fpring, and defcribe the two given Semicircular Arches O A B, C L D, and in the Line B D fet off the Spand of the Interfecting Arch from *v* to *t*. This being done, fet off the Heighth you defign to rife the lefer Arch *v z u* from *g* in the Line A O B, perpendicularly to touch the Arch in *h*, and from *v* to R, and *t* to *u*, and draw the Line R *u*, which halve in the Point *z*, and draw the Line *z y*, parallel to *v* R, or *t v*. Then ftrain a Line, or lay a ftraight Rule
from

from *h* thro' *g*, towards *x*; as also from *z* thro' *y*, towards *x*, and these two Lines will cut one another at *x*, from whence to the Points *v* and *t* draw the Lines *x v* and *x t*. Now set off *g h* perpendicular to *x t* from *x* to *w*, and from *t* to *s*, and draw the Line *s w*, and divide *g* B into any Number of equal Parts at pleasure, from the Divisions of which draw Perpendiculars to *g* B, to touch the Arch BOA between the Points B and *h*, and divide *v y* and *y t*, the Halves of the Base *v t*, each into the same Number of equal Parts, as *g* B is divided into; as likewise the Base *x t*, and from the Points of Division draw parallel Lines to touch the Lines *u* R and *s w*. This being done, take the Lengths of the Lines that were drawn from the Points of Division of B*g*, perpendicularly to touch the Part B*h* of the Arch BOA, and set them off in the correspondent Parallels from *y v* to *z* R, and from *y t* to *z u*; as likewise from *x t* to *w s*. Then, if at the Extent of each Line as you set it off in the Parallels, you stick in Nails, as in the foregoing Examples, and bend a thin Ruler about them, you will describe the sought Arches *v z t* and *w t*, whereof *v z t* is the true Intersecting Arch, and *w t* the Curve Line of the Groin that is correspondent thereto.

After the very same Manner the Arches *k m z* and *k p* are drawn.

PROBLEM XXVII.

The Arch-Line of a Ceiling, or Vault, supposed to be an Ellipsis, being given, how to form the Curve of a lesser Arch, to give way for Doors, or Windows, that shall intersect the Side thereof so, that their Intersection shall produce the Groin, or Mitre-Arch, to hang perpendicularly; as also to form the Arch-Line thereof.

FIGURE XXVII.

FIRST describe the Lines A B, B D, D C, and C A, representing the Walls from whence the Arches

G   spring,

spring, and in the Line A C set the Spand of the Arch *k z*, and on the Lines A B and C D describe the Semi-Ellipses A O B, C L D, representing the given Arches. Then take the Heighth you design to rise the lesser Arch, and set it perpendicularly from the Line A B, as at *e*, to touch the Arch A B at *f* : Also set the same Heighth from *k* to *i*, and from *z* to *q*, and draw the Line *i q*. This being done, draw a Right-Line at pleasure from *f* thro' *e*, towards *o*, and another from *m* thro' *n*, cutting it in the Point *o*, from which draw the Lines *o k*, *o z*, and take *m n*, the Heighth of the lesser Arch, and set it perpendicularly from *o* to *p*, and from *k* to *l*, and draw the Line *p l*. Then divide A*e* into any Number of equal Parts at pleasure, from the Divisions of which draw Perpendiculars to A B, to touch the Arch A O B, and divide the Lines *z u*, *n k*, and *o k*, as in the last Problem you did the Lines *v y*, *y t*, and *x t*, and draw Parallels as there. Now, if you take the Lengths of the Lines that were drawn from the Points of Division of A *e*, perpendicularly to touch the Part A*f* of the Curve A O B, and set them off in the correspondent Parallels, from *k z* towards *i q*, and from *o k* towards *l p*, and at the Extent of each Line stick in Nails, as in the foregoing Examples, you may describe the sought Arches *k m z*, and *k p*.

After the very same Manner may the Arches *v z t* and *t w* be drawn.

PROBLEM XXVIII.

The Arch of a round Tower, or any other Circular Building, being given, wherein a semicircular Window is to stand; how to form a Centre so, that the Mason, or Bricklayer, shall twin their Arches thereon without crippling them.

FIGURE XXVIII.

FIRST draw the Arch A F B from the Centre E, to represent the Arch-Line of the Wall, and set the Width of the Window from C to D, which halve at H, and

Plate 4

Fig. 25.

Fig. 26.

Fig. 27.

Fig. 28.
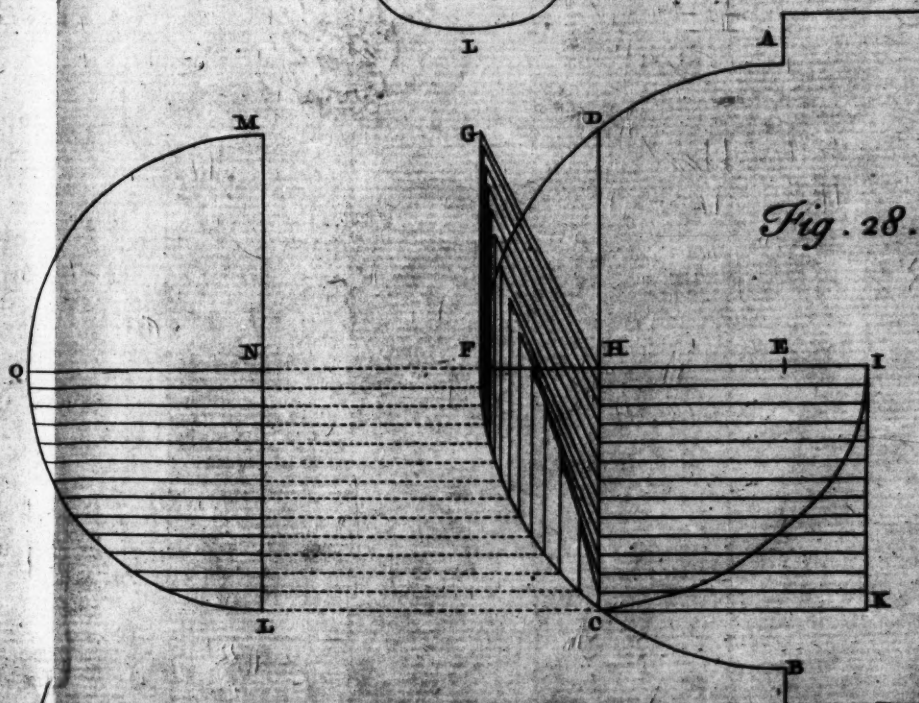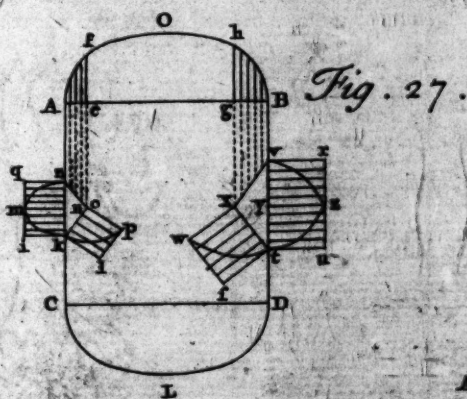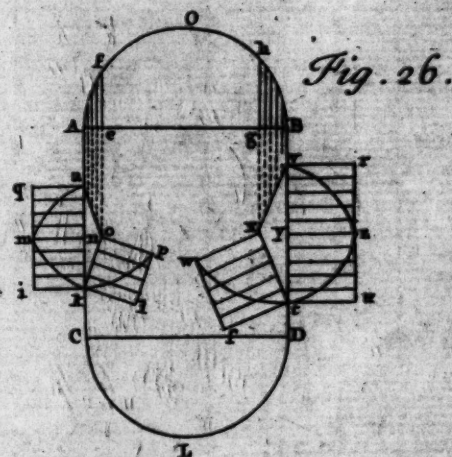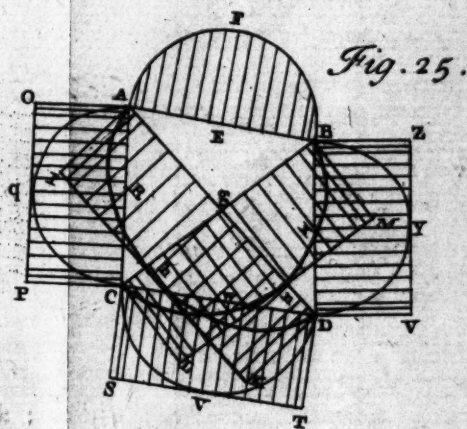
and draw the Line L M, which halve at N; from whence deſcribe the Semicircle L O M. This being done, divide the Semidiameter L N into any Number of equal Parts, from the Diviſions of which draw parallel Lines to O L, the Arch of the Quadrant, which Parallels continue out to divide the Arch F C into the ſame Number of Parts as L N is, and from the Points of Diviſion in the Arch F C draw Perpendiculars to the Parallels, each equal in Length to the correſpondent Parallel of the Quadrant L O; and from the Points of the Diviſions of the Line H C, (made by continuing out of each of the aforeſaid Parallels,) draw Right-Lines to the extreme Points of the aforeſaid Perpendiculars, as from G to H. This being done, if the Line G H be laid off in the Parallel O N continu'd out from H to I, and the reſt of theſe Lines laſt drawn be laid off in the reſpective Continuations of the Parallels, the extreme Points of theſe Lines being joined, will form the Curve C I, which, when ſet in its due Poſition will hang perpendicularly over the Arch C F, having its Points co-inciding with the Extremities of the Perpendiculars drawn from the Extremeties of the Perpendiculars drawn from the Diviſions of the Arch C F.

SECTION III.
Of the Formation of Niches.

PROBLEM XIX.
How to form a Semicircular Nich with Ribs, as is uſual when it is to be plaſter'd.

FIGURE XXIX.

FIRST deſcribe the Semicircular Plate A C B, as alſo the Semicircular Front-Rib A D B, equal to it, and fix the Plate A C B level in the Place where it is to continue,

and

and upon it set the Front-Rib ADB perpendicular on AB.
This being done, defcribe the Quandrantal Ribs DC, DE,
DF, DG, and DH, each equal to AD or BD, and place
them about eight Inches and a half from one another on
the Plate ACB, as at C, E, F, G, and H, fo as to meet in
one Point at D on the Crown of the Front-Rib ADB;
and thus is one half of the Work finifhed. And after the
fame Manner may the other be done.

PROBLEM XXX.

*How to form a Semicircular Nich by the Thick-
neffes of Boards, or Planks, and to find the Be-
vel of each Thicknefs.*

FIGURE XXX.

FIRST defcribe the Semicircle on the Front of the
Nich ADB, and divide the Heighth *e*D into equal
Parts, according to the Thicknefs of the Board or Plank,
of which you defign to make the Nich. Then defcribe the
Thickneffes from whence the Bevels are taken, and draw
Lines equal to the prick'd Lines in the Example. This
being done, take the prick'd Line 12 in your Compaffes,
and on the under Side of the Board, or Plank, of which
you defign to make the firft Thicknefs, defcribe a Semicir-
cle from 1 equal to ADB, the Semidiameter being equal
to the prick'd Line 12. Then ftrike a fquare Stroke on
the Edge from 1, to find the Centre for the Semicircle on
the upper Side of the firft Thicknefs, as at 3, and take the
prick'd Line 34 in your Compaffes, fetting one Foot in 3,
with the other draw a Semicircle on the upper Side of the
firft Thicknefs, whofe Semidiameter is equal to the prick'd
Line 34. Having an Arch defcribed on each Side of the firft
Thicknefs, with a narrow Turning-Saw cut directly thro'
the Arch-Line on each Side the Board, or Plank, and fo
you will have the true Bevel and Curve thereof.

Now, to make the fecond Thicknefs, defcribe the Semi-
circle laft drawn on the under Side thereof, as you did on
the

the upper Side of the first Thickneſs, 34 being alſo the Semidiameter equal to it. Then ſtrike a ſquare Stroke from 3 on the Edge of the Board, or Plank, to find the Centre for the Semicircle on the upper Side of this ſecond Thickneſs, and take the prick'd Line 56 in your Compaſſes, and ſetting one Foot in 5, with the other deſcribe a Semicircle on the upper Side of the ſecond Thickneſs, having its Semidiameter equal to 56. Then with a Turning-Saw cut thro' the two Arches in the firſt Thickneſs, and the Arch-Line and Bevel of the ſecond Thickneſs will be finiſhed.

To find the Arch-Line and Bevel of the third Thickneſs, you are to proceed after the ſame Manner as in the firſt and ſecond Thickneſs, and ſo of the others.

Having your Thickneſſes all ready, according to their true Arches and Bevels, ſet them in good and well-made Glue, letting it ſtand till it be quite dry, and with a Compaſs Smoothing-Plane, a little quicker than the Arch of the Work, plane the Inſide thereof till it be fit for the Purpoſe deſign'd.

PROBLEM XXXI.

How to form an Elliptical Nich, with Ribs for Plaſtering.

FIGURE XXXI.

FIRST deſcribe the two Figures 32 and 33, *k n m* being a Semi-Ellipſis, repreſenting the Plate, whereon the Ribs ſtand, and being equal to ADB or A*e*B. The prick'd Lines *l n, l o, l p, l q, l R,* and *l w* repreſent the Baſe Lines of the Ribs *e*D, *f*D, *g*D, *h*D, *i*D, and BD; ſo likewiſe do the Lines *s t, s u, s w, s x,* and *s y,* and the Perpendiculars *a t, b u, c w, d w, e x,* and *f y,* do repreſent the Riſing of the Ribs *e*D, *f*D, *g*D, *h*D, *i*D, and *b*D, which is equal in Length to CD; obſerving that within thoſe Lines the different Arch of each Rib is to be deſcribed, *viz.* the Arch *s a* is a Quadrant of a Circle, having *t* for its Centre,

and is equal to the Arch of the Rib *e* D. The Lines *u s*, *s z* equal to *z b*, *b u* are the Semi-tranverse and Conjugate Axes of a Semi-Ellipsis, whose Arch *s b* is equal to the Arch of the Rib *f* D, which may be struck either with a Tramel, or by the Intersection of Lines. Moreover, the Lines *s z*, *s v*, equal to *v c*, *c z*, are the Semi-tranverse and Conjugate Axes of a Semi-Ellipsis, whose Arch is equal to the Arch of the Rib *g* D, and so of the rest.

Now having the Ribs all ready, set the Front-Rib ADB perpendicular on the Plate A *e* B, as at A B, and fix the Feet of the short Ribs on the Plate A *e* B, as at *e*, *f*, *g*, *h*, *i*, which correspond with the Points *n*, *o*, *p*, *q*, *r*, and their Points *a*, *b*, *c*, *d*, *e*, to the Crown of the Front-Rib at D; and thus may you finish your Work.

PROBLEM XXXII.

How to form an Elliptical Nich by the Thickness of Boards, or Planks. (See Fig. XXXIV.)

FIGURE XXXIV.

FIRST on a Drawing-Board, or Floor, describe (*Figure* XXXIV, XXXV, XXXVI, and XXXVII,) the Arch ABC and *f g h* being Semi-Ellipses equal to one another. The Arch *l n* is a Quadrant of a Circle, and the Arch *o p* is a Quadrant of an Ellipsis; being the two most different Arches of the Nich. The Arch *f g h* represents the first Thickness, and is equal to ACD, and the perpendicular Lines *m n* and *g p* are equal to *e* B, and the Base Line *l m* is equal to *i g*. Moreover, the Base Line *o g* is equal to *i k*, whose Arches *l n*, *o p*, with their Bevels, do stand perpendicularly over *i g* and *i k*.

Now take the Board, or Plank, of which you design to make the first Thickness, and on the under Side thereof describe a Semi-Ellipsis equal to ADC, or *f g h*, whose Semi-tranverse Axis is equal to the prick'd Line 1 2, and Semi-conjugate to 1 3: Then at 1 strike a square Stroke on the Edge of the Board, or Plank, to find the Middle of
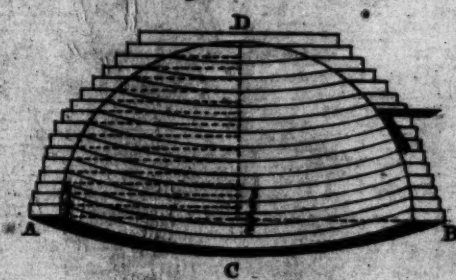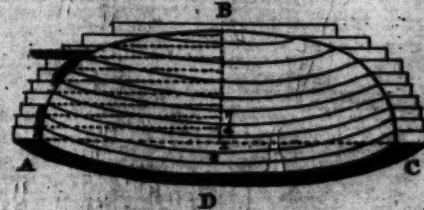
the

Plate 5.

Fig. 29.

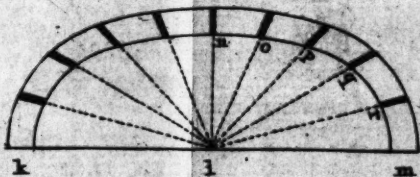Fig. 30.

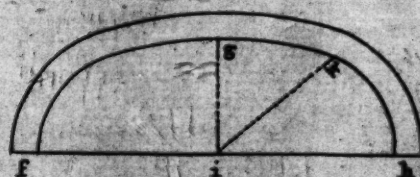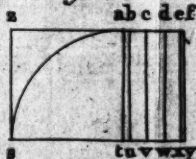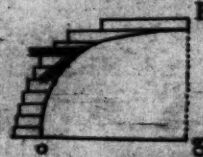Fig. 31.

Fig. 34.

Fig. 32.

Fig. 35.

Fig. 33.

Fig. 36.

Fig. 37.

the Bafe to the Elliptick Arch on the upper Side of the firft Thicknefs at 4, whofe Semi-tranverfe is equal to the prick'd Line 45, and Semi-conjugate equal to the prick'd Line 46, by Means of which defcribe an Elliptick Arch on the upper Side of the firft Thicknefs. Then by Means of thefe two Elliptick Arches, defcribed upon the upper and under Side of the Piece, with a Turning-Saw, faw out the Curve and Bevels of the firft Thicknefs.

To find the Arch and Bevels of the fecond Thicknefs on the under Side of the Board, or Plank, of which you defign to make it, defcribe an Elliptick Arch equal to that on the upper Side of the firft Thicknefs, whofe Semi-tranverfe and Semi-conjugate Axes are alfo equal to the prick'd Lines 45 and 46. Then from 4 ftrike a fquare Stroke on the Edge, to find the Middle of the Bafe Line to the Arch on the upper Side of the fecond Thicknefs, whofe Semi-tranverfe is equal to the prick'd Line 78, and Semi-conjugate equal to the prick'd Line 79, and with a Turning-Saw, as before, faw out the Arch and Bevels thereof; and fo of the reft.

SECTION IV.

Of the Formation of Twifted Rails.

PROBLEM. XXXIII.

How to find the Raking Arch, or Mold, for the Hand-Rail to a Circular Pair of Stairs, in fuch Manner that it fhall ftand perpendicularly over its Bafe, or Arch of the Well-Hole.

FIGURE XXXVIII.

FIRST defcribe a Circle equal to the Breadth of the Well-Hole, whofe Diameter is UW; as alfo another from the fame Centre, whofe Diameter is AG, to

repre-

repre&sent the Plan of the Rail, and divide the Circumfe-
rence of the greater Circle into the &same Number of equal
Parts as you would have Steps once round the Circle.

This being done, take the Back, or Rake, of the Bracket
equal to C F in your Compa&s&ses, and &setting one Foot in
A, with the other &trike the Arch *h*: Al&so take the Heighth
of one Step, as A C, *Figure* XL, and &setting one Foot in B,
with the other &trike the Arch *i*; and when this is done,
take the Di&tance from A to *h* in your Compa&s&ses, and
&setting one Foot in *h*, with the other &trike the Arch *k*,
and take the Heighth of two Steps, and with one Foot in
C draw the Arch *l*, to inter&ect the Arch *k*, and &so on. The
Inter&ecting Points of the Arches *h i*, and *k l*, and *n o*, and
r s, and *t u*, are all at the &same Di&tance from one another,
and the Lines B*h*, C*k*, D*n*, E*p*, F*r*, G*t* being the Ri&sings
or Heighths of the Steps in *Figure* LX, B*h* being the
Heighth of one Step, C*k* of two, D*n* of three, E*p* of four,
F*r* of five, G*t* of &six. Now if the&se Lines are rai&sed up
perpendicular on the Circle A D G, it is evident that the
Point of Inter&ection of the Arches *h* and *i* will &tand per-
pendicularly over the Point B; of the Arches *k, l* over C; of
the Arches *n* and *o*, over D; of the Arches *p* and *g*, over E;
of the Arches *r* and *s*, over F; and of the Arches *t* and *u*,
over G. Now if Nails be &truck into the inter&ecting Points
of the &said Arches, and a thin Rule be bent round them,
you may de&cribe the Arch A*hknprt* by the Edge thereof,
being the Mold, to &trike the Arch of the Rail with.

PROBLEM XXXIV.

The Arch or Mold of the Rail being found, as
above, how to prepare the Stuff of which the
Rail is to be made, and work the Twi&t there-
of without &setting it up in its due Po&sition.

FIGURE XXXIV.

FIRST &trike two Circles, who&se Diameters are equal
to U W and A G, in *Figure* XXXVIII. and next con&si-
der

der into how many Pieces you glue the Rail; which in the
Semicircle let be six, as in the Example.

Now divide the Semicircle into six equal Parts, as EF,
FM, MS, SL, LD, and DK, from each of these Points of
Division, draw Lines to the Centre A, as AE, AF, AM,
AS, AL, AD, AR. Then from F raise FG, perpendicu-
lar to AF, and equal to the Heighth of one Step: Also at
the Point M raise MN, perpendicular to AM, equal to the
Heighth of two Steps; and in like Manner at the Points
S, L, D, and R, raise the Perpendiculars ST, LY, DE,
and RL, respectively equal in Length to the Heighth of
three, four, five, and six Steps. Then draw a Line from
G to R, parallel and equal to AF; as also another from
N to *y*, parallel and equal to AM; another from T to W,
parallel and equal SA; another from Y to B, parallel and
equal to LA; another from E to H, parallel and equal to
DA; and another from L to P, parallel and equal to RA.
From the Point A draw the Line AB, perpendicular to
AE, and equal to the Heighth of one Step; also at the
Points R, *y*, W, B, H, P, draw the Lines RL, YZ, WX,
BC, HI, PO, all equal to the Heighth of one Step, and
respectively perpendicular to RG, *y*N, TW, YB, EH,
LP, and draw the Hypothenuses EB, LG, ZN, TX, YC,
EI, LO.

This being done, set off the Width of the Rail from E to *d*,
G to *i*, N to *o*, T to *u*, Y to *a*, E to *f*, and L to *m*; and
set the Stem of a Square on the Line EB, till the Blade
thereof touches the Point *d*, and draw the Line *c d*. More-
over, set a Square on the Line GL, and where it cuts the
Line RG, as in the Point *i*, draw the Line *h i*; and in like
Manner draw the Lines *po*, *un*, *za*, *gf*, and *nm*. Then
the Angles E*dc*, G*ih*, N*po*, &*c*. and the rest of the little
black Spaces, as you see in the Figure, do represent the
Twisting of each Piece, and what must be taken off from
the Back at the lower End, to make the Twist of the Rails.
The Lines being drawn, you are next to consider after
what Manner they are to be applied in the working of the
Rail.

Take the Piece of Timber, of which you design to
make the first Length, which is represented in *Figure* XLI,
and plane one Side thereof straight, and cut it to its Bevels

I   *a c*,

a c, *b d*, anſwering to DR A and RDA, *Figure* xxxIx, and both Ends thereof being alſo cut to the Raking Joint of the Rail, proceed thus: Take that Part of the Raking Arch in *Figure* xxxvIII, which anſwers to the firſt Length of the Rail, as A *k* in the Arch A *z*, and lay it on the upper Side of *Figure* xLI, from *l* to *h*, and ſtrike the Arch *l h*; then take E *c*, equal to G *h* or N *p*, in *Figure* xxxIx, and ſet it on the Line *b d* from *h* to *m*, (*Figure* xLI,) and ſtrike a ſquare Stroke at Pleaſure from *m* to *g*; alſo take *c d* equal to *h i*, or *p o*, &c. and ſet it on the Line from *m* to *g*, and draw the Line *h g*, which repreſents the Back of the Rail when it is work'd, and is equal to E *d*, or G *i*, or N *o*, &c. This being done, repreſent the lower End of the Rail *h g k i*, at Right-Angles to *h g*; as alſo the upper End *l c o n* at Right-Angles to *l c*, and baſte out the inward Arch *c m* ſquare from the upper Side *a b c d*, as *m g*; and take a thin Lath, and bend it cloſe to the Side thereof from *c* to *g*, whereon ſtrike a Line along the Edge of the Lath, and ſo the Lines *l h* and *c g* are your Guides in backing the Rail: Which, when done, turn the Piece upſide down, and with the Mold ſtrike an Arch equal to *l h* from *a* to *k*, and baſte out the Side to the Lines *l h* and *o k*. Then you have one Side, and the Back ſquar'd, which is the greateſt Difficulty in the Formation of a Twiſted Rail, becauſe the two other Sides are found by gauging from them.

Note, If the Triangles in *Figure* xxxIx, and Lines whereon they ſtand be ſuppoſed to be raiſed up perpendicularly, then will the Lines AB, KL, *y*Z, WX, BC, HI, PO, join to each other, and produce one Line perpendicularly over A, equal to ſeven Riſings or Heighths of the Steps. But in working a Rail of this Kind, you have need of but one Triangle AB *c* E *d*, becauſe they are all equal, and of but one Effect in working, they being drawn only to ſatisfy the Curious in the Nature of the Thing.

PRO-

PROBLEM XXXV.

How to frame the Arch, or Mold for a Hand-Rail to an Oval Pair of Stairs, so that the same shall stand perpendicularly over the Profile, or Arch of the Well-Hole.

FIGURE XLII.

THE Arch A *kmoqswy* is found after the same Way as the Arch A *bknprt* is found in *Figure* XXXVIII; and *Figure* XLIII bears the same Relation to *Figure* XLII, as *Figure* XXXIX does to *Figure* XXXVIII, and is made thus: *a, b, c,* C, are the Centres, by means of which the Oval is made; *a* being the Centre for striking of the Part G*o* of the Oval, from whence the Lines *a*G, *ah,* *a*I, are drawn; *b* the Centre for striking the Arch *nz,* from whence are drawn the Lines *bz, bm,* and *b n*; and C is the Centre for drawing the Arch *g u,* from whence the Lines *cg, c* A, *c u* are drawn, which Lines shew where the Rail must answer square.

Now to *ah* raise a Perpendicular from *h* to I, equal to the Rising or Heighth of one Step of the Stairs, and from O to *a*O raise a Perpendicular to P; raise another to *c u,* from *u* to V; another from to *c* A, from A to Z; another to *c g,* from *g* to *h*; another to C*n,* from *n* to *o*; another to *b t,* from *t* to *u*; and another to *a b,* from *z* to I. Then from I draw the Line I *m,* equal and parallel to *ah*; from P the Line P S, equal and parallel to *ao*; from V the Line V Z, equal and parallel to *uc*; from B the Line B F, equal and parallel to C A; from H the Line H L, equal and parallel to *gc*; from *o* the Line *oz,* equal and parallel to *uc*; from *u* the Line *u x,* equal and parallel to *tb*; and from I the Line 14, equal and parallel to *ab*. This being done, at the Points *a, m,* S, Z, F, L, *z, x,* 4, to the Lines *ab,* I *m,* PS, VZ, BF, HL, *oz, ux,* 14, raise the Perpendiculars *a*D, *m n,* ST, ZY, EF, ML, S*z, y x,* 45, each equal in Length to the Heighth of one Step, and draw the Hypothenusal

thenufal Lines DG, *n*I, TP, YV, EB, MH, *o s*, *u y*, 15, and fet off the Width of the Rail from G to *e*, I to *l*, P to *z*, V to *x*, B to *d*, H to *k*, *o* to *p*, *u* to *v*, and 1 to 3, and fet the Stem of a Square on the Line GD till the Blade cuts the Point *e*, and draw the Line *e f*. After the fame Manner fet the Stem of a Square on the Line *n* I, till the Blade touches *l*, and draw the Line *k l*, and fo draw the other Lines *q z*, *w x*, *cd*, *i k*, *q p*, *w v*, 23, as in the laft Problem.

Note, If the Triangles in this Figure were raifed up perpendicularly, then would *a* D, *mn*, ST, ftand perpendicularly over *a*, and *z* Y, FE, ML, perpendicularly over the Point C; and *z s*, *y x*, 45, perpendicularly over the Point *b*; fo that in this Figure you will have Occafion for two different Triangles, becaufe there are two different Sweeps that are the Caufe of two different Twifts in the Rail; and fo the the Triangles *a*GD, VZY, are enough for fquaring of this Rail; and always obferve, that as many different Sweeps as are contain'd in the Ground Work of the Rail, there are fo many different Twifts, and confequently fo many different Triangles, becaufe the Twift is found by Means of them.

PROBLEM XXXVI.

How to form the Arch or Mold to the Hand-Rail of a Pair of Stairs that fweep two Steps, fo as to ftand perpendicularly over its Ground, and the Manner of fquaring the fame, without fetting it up in its Pofition.

F I G U R E XLIV, XLV, XLVI, XLVII.

FIRST draw *Figure* XLIV, to reprefent the Ground-Work of the Rail, whofe Arch GC confifts of two different Arches, one whereof is a Quarter of a Circle, and the other a Quarter of an Oval. AB (equal to AC, equal to CD, equal to BD) is equal to one Third of a Step, and D is the Centre to the Arch CB: Alfo BF is equal to two Thirds of a Step, and FG is equal to one Step and two
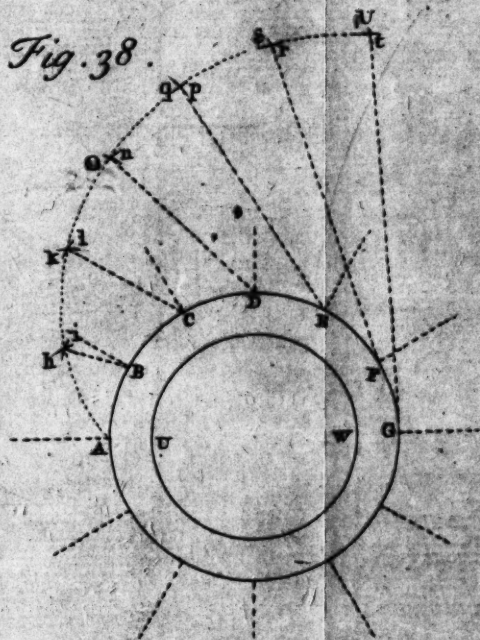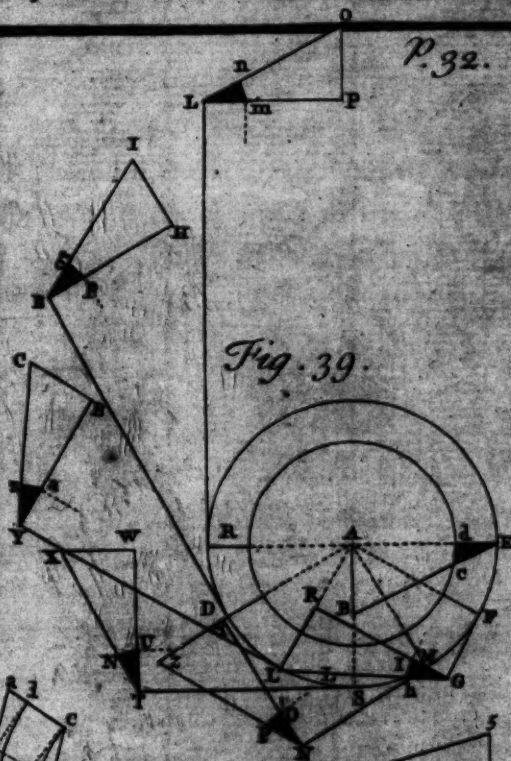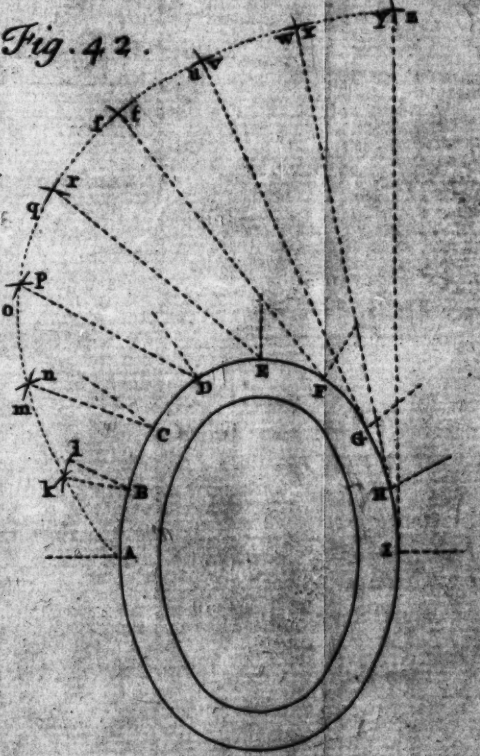
Thirds,

Fig. 38.

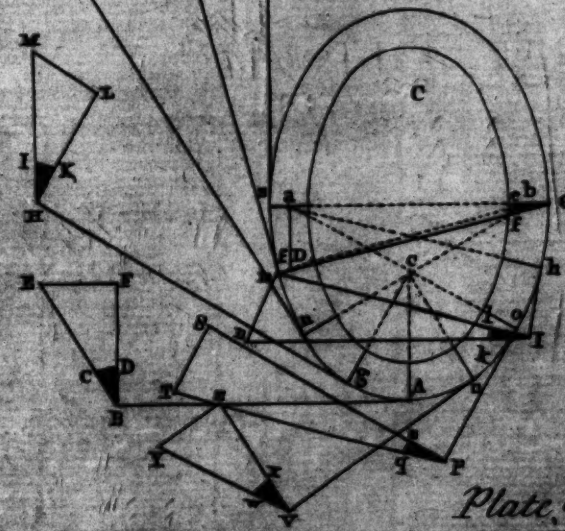Fig. 39.

Fig. 41.

Fig. 40.

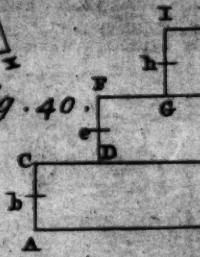Fig. 42.

Fig. 43.

P. 32.

Plate. 6.

Thirds, by Means of which, and B F, is the Arch G B deſcribed. G K repreſents the ſtraight Part of the Rail to one Step, and the Arch H D is drawn by gauging from the Arch G C, that is, it is drawn parallel to it; and the ſtraight Part I H is found by gauging from K G, or is drawn parallel to it.

Figure xlv. ſhews the Manner of drawing the Rake or Arch of the Rail, which is done thus: Draw I L equal to G K of *Figure* xliv. and repreſent the Tread of the Steps, as before, by prick'd Lines. Then divide that Part of the Ground-Work of the Rail that belongs to each Step into any Number of equal Parts, as A F into 5, and F K into 4. This being done, draw A B, B C, C D, in *Figure* xlvi. to repreſent the Riſing and Tread of the Steps; and continue out the Line C B, at Pleaſure, towards T, in which ſet the five Diviſions on the Ground of the Rail to the firſt Step, F E, of *Figure* xlv. being equal to C I, of *Figure* xlvi. alſo E D equal to *i k*, D C to *k l*, C B to *l u*, and B A to *u* T. Then will the Line C T, in *Figure* xlvi. be equal to the Arch A F of *Figure* xlv. draw the Line D T. Then is the Triangle C D T the Bracket to the firſt Step, according to the Sweep of the Rail; and as T C is the Length of the Ground to the firſt Step, ſo is T D the Length of the Rail anſwering to it. Then from the Points *i, k, l, u,* raiſe the Perpendiculars *i* P, *k* Q, *l* Z, *u* S, to C T, and take the four Diviſions on the ſecond Step, and ſet them in the Line C T, from C to B, and draw the Line B D; and then is B C the Length of the Ground to the ſecond Step, and B D the Length of the Rail anſwering to it. Draw Lines through theſe Diviſions, as from F to *m*, G to *n*, and H to *o*, perpendicular to C B; and ſo your Perpendiculars are found, according to the Compaſs-Brackets of each Step, and may be pieced thus.

In *Figure* xlvi. take T S in your Compaſſes, and with that Diſtance, ſetting one Foot in A, in *Figure* xlv. ſtrike the Arch *m*, and take S *u* between your Compaſſes, and with one Foot in B ſtrike another Arch to interſect the Arch *m*. Again, take S Z, or S T, in your Compaſſes, and with one Foot in the Interſection of the Arch *m*, and this latter Arch, deſcribe the Arch *n*; and take *l* Z in your Compaſſes, and with one Foot in C, deſcribe an Arch to inter-

ſect

fect the Arch *n*; and thus proceed on, so that zq be equal to *no*, QP to *op*, PD to *pq*, *qz* to B*o*, *zs* to *on*, *st* to *nm*, and *tu* to *m*D; as also *k*Q to D*o*, *i*P to E*p*, CD to *q*F, H*o* to G*z*, G*n* to HS, F*m* to I*t*, ED to K*u*, L W to three Times A B. The Points *n, o, p, q, r, f, t, u, v,* W, being found by the Interfection of Arches, as above, stick a Nail into each Point, and bend a thin Rule about the Nails, till it touches them all, then with a Pencil describe an Arch round the Edge thereof, which will be the Arch A W, being that of the Rail to work by.

Figure XLVII. shews the Manner of squaring the Rail, which is thus: First describe A F, the Square, or Ground of the Rail, being the same as that of *Figure* XLIV, and find the Centers to answer to the different Arches of the Ground; from whence draw prick'd Lines to the Places where you design to join the Rail, as from G to B, from G to C, from H to E, and from H to *d*. Because the first Step is to be joined in three equal Pieces, you must take one Third of the Rising or Heighth of the Step, and set it from B to I, perpendicular to B G, and draw the Line M I, parallel and equal to G B. Now from M to *n* draw a Perpendicular to M I, to rise so much as the Rail rakes over, which is one Third of the Rising or Heighth of the Step, because that Part of the Rail is one Third of the Length on the first Step, and draw the Line I *n*, by which Means we shall have the first Triangle I M *n*. Then from the Point C draw C *q*, perpendicular to G C, and equal to two Thirds of the Heighth of one Step, and draw the Line *qz*, equal and parallel to C G, and from *z* raise a Perpendicular *zs* to *zq*, equal to one Third of the Heighth of one Step, and draw the Line *qs*, and you will have a second Triangle. Again, from *d* draw *d* T, perpendicular to H *d*, and equal to the Heighth of one Step, and draw the Line T W equal and parallel to H *d*; and from W erect the Line W X, perpendicular to W T, and equal to the Heighth of one Step, because that Part of the Rail over the second Step will be one Piece, therefore the Triangle must rise one Heighth of the Step, and draw the Line T X, and so you will have a third Triangle W X T. This being done, from I, in the Line I M, set off I *k*, equal to the Width of the Rail; also set off the same from *q* to *o*, and T to *u*, and

setting

setting the Stem of a Square on the Hypothenusal Line, so that the Blade thereof touches the Point *k*, draw the Line *k l*; and in the like Manner draw the Lines *po, u v*; and then the little Triangles I *k l*, *q o p*, T *u v*, do represent what must be taken off from the lower End of each Piece, to bring the Rail to its true Twist.

PROBLEM XXXVII.

How to form the Arch or Mold of the Hand-Rail of a Pair of Stairs that sweeps two Steps quicker than in the foregoing Examples.

FIGURE XLVIII, XLIX, L, LI.

FIRST describe *Figure* XLVIII, representing the Ground or Plan of the Rail where A E is equal in Length to the Heighth of one Step, and A C and A B are the Halves thereof, and D is the Centre to the Arch F C B, which is greater than a Quadrant. B G is six Sevenths of the Width of a Step, and G H is one Step and two Thirds of one, and from these Lines the Arch H B is made.

Figure XLIX. reprefents the Ground and Raking Arches of the Rail, whereof the Arch A M is equal to the Arch F H I, of *Figure* XLVIII. and the Raking Arch thereof is found by the fame Means, and bears the fame Proportion to *Figure* LI. as the Arch A *u* W in *Figure* XLV. does to *Figure* XLVI. and the feveral Lines are equal to one another, *viz.* A B, in *Figure* XLIX. is equal to Q P, in *Figure* LI. P O is equal to B C, O B to C D, B *k* to D E, *k i* to E F, *i c* to F G, A H to G H, H G to H I, G F to I K, and E F to K L. Moreover, *Figure* XLIX. A *n* is equal to Q V, *Figure* LI. *n o* to V U, *o p* to U T, *p q* to T S, *q z* to S Z, *z s* to Z D, S *t* to B *n*, *t u* to *n m*, *n v* to *m l*, and *v w* to *l* D. The Perpendiculars are also equal to one another, *viz.* B *n*, in *Figure* XLIX. is equal to P V, *Figure* LI. C *o* to O U, D *p* to B T, E *q* to *k* S, F *z* to *i* Z, G S to C D, H *t* to H *n*, I *u* to G *m*, K *v* to F *l*, L *w* to E D, and M *x* to three Rifings of a Step. Now, as in the foregoing Examples, the Arch G A, which is the
Ground

Ground for the Rail to the firſt Step in *Figure* XLIX, is equal to the Line CQ in *Figure* LI. likewiſe the Line QD is equal to the Arch A F. Again, BC is equal to GL; BD is equal to S*w*, and *nm* is equal to the Rake of that Part of the Rail that ſtands over FH; and the Triangles C*lk*, E*st*, G*uv*, do repreſent what muſt be taken from the lower End of each Piece to make the true Twiſt.

SECTION V.

Of *Working of Arches and Niches in Stone and Brick.*

PROBLEM XXXVIII.

How to work a ſtreight Arch with Stone or Brick.

FIGURE LIV.

FIRST draw the Line CD expreſſing the Width of the Door or Window over which the Arch is to ſtand, and draw the Line A B, of a Length at Pleaſure, parallel to C D, and at ſuch a Diſtance from it as the Front of the Arch is in Heighth. This being done, draw the prick'd Lines C*f*, D*g*, at Right Angles to the Line CD, and in the Line A B ſet off the Skew-Back from *f* to E, and from G to *h*, and lay a ſtraight Rule on the Points E, C, and draw a Line downwards along the Edge thereof towards I; then remove that Rule, and lay it on the extreme Points H, D, and by the Edge thereof draw a Line to cut that laſt drawn in the Point I, and the Point I will be the Centre to which the Skew-Backs, and the Points of each Courſe are directed, and they may be work'd thus:

Take IE, or IH, between your Compaſſes, and ſetting one Foot in I, with the other ſtrike the Arch EH, in which ſet off the Thickneſs of every Courſe, as in the
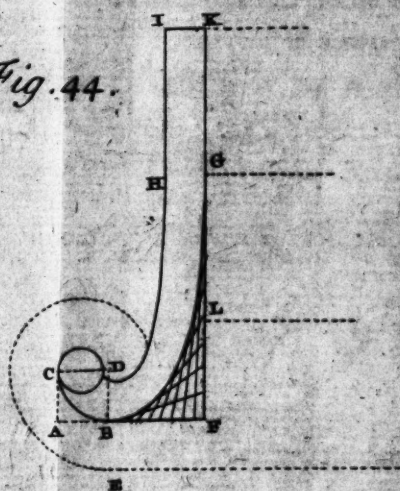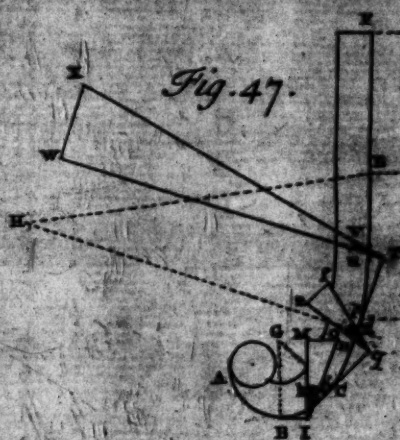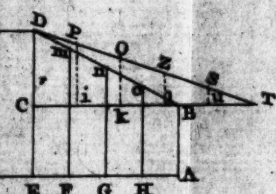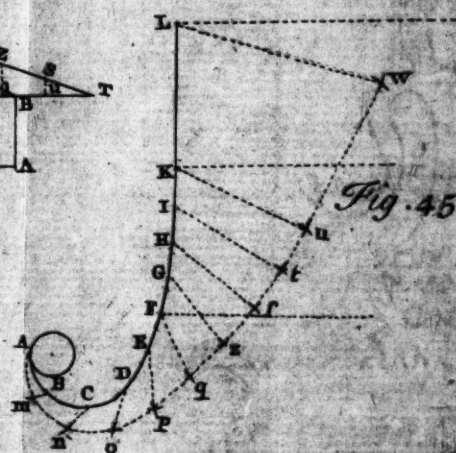
Example

Fig. 44.

Fig. 47.

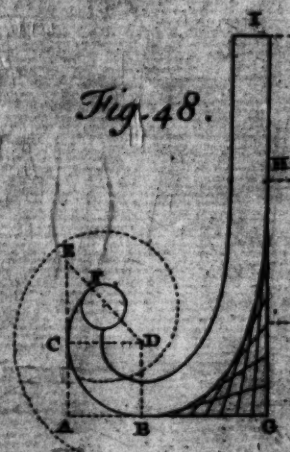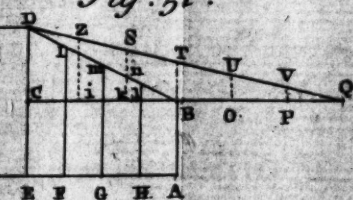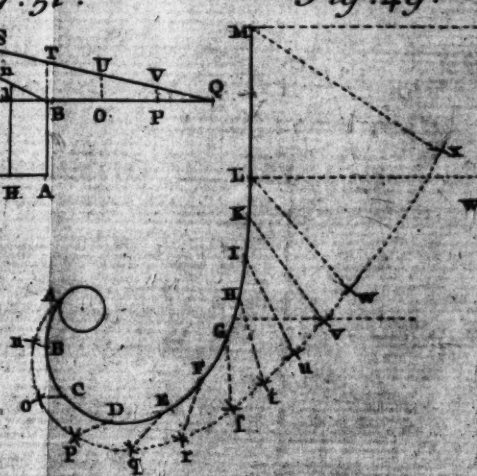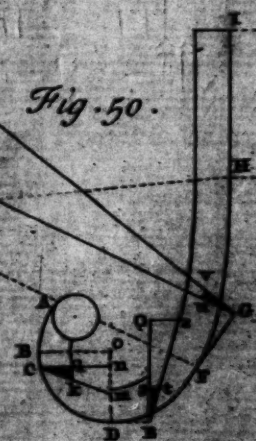Fig. 46.

Fig. 45.

Fig. 48.

Fig. 51.

Fig. 49.

Fig. 50.

Plate 7.

Example mark'd E 1, 12, 23, 34, 45, 56, 67, &c. This
being done, lay a straight Rule from 1, in the Arch E H, to
I, and along the Side thereof draw the Line 11, from the
Line A B to the Line CD, which represents the first
Joint; also lay your straight Rule from 2, in the Arch E H,
to I, and along the Side thereof draw the Joint 22, from
the Line A B to the Line CD, and you will have the se-
cond Joint; and proceeding thus you will have all the
Upright Joints.

When this is done, mark the Cross Joints parallel to
the Lines A B, CD, as in the Example, and they will de-
note the true Bevels of the Arch, according to which the
Stone, or Bricks, are to be work'd.

PROBLEM XXXIX.
How to work a Scheme-Arch with Stone or Brick.
FIGURE LV.

FIRST draw the Line CD to represent the Width of
the Door, or Window, over which the Arch is to stand,
and find the Centre E by the Example of *Figure* III, ac-
cording to the Heighth you have a mind to raise the Arch
CD. This being done, describe the Arch CD from that
Centre, and from the Point E thro' the Points C, D, draw
two Right Lines E A, E B, of Lengths at Pleasure, and in
them, from the Points C, D, set off the Heighth of the
Front of the Arch to the Points A and B; and taking AE or AB
between your Compasses, set one Foot in E, and with the
other draw the Arch A B, and from E strike the Cross
Joints, the upright ones being mark'd after the same
Manner as those in the last Problem.

PRO-

PROBLEM XL.

How to work a Rampant Scheme-Arch with Brick or Stone.

FIGURE LVI.

FIRST draw the Line CE to reprefent the Width of the Door, or Window; then draw the Line CD, and proceed to find the Arch CD, according to the Directions in *Figure* v. which when defcrib'd, from the Points C, D, raife the Right Lines C*h*, D*i*, perpendicular to CE, and draw the Line AB parallel to CD, and fo far diftant from it as you defign the Heighth of the Front of the Arch to be, and from the Points F, *g*, draw a Right Line downwards towards K. This being done, in the Line AB fet off the Skew-Back from the Perpendicular C*h* to A, and from the Perpendicular D*i* to B, and laying a Ruler on the Points A, C, along the Edge thereof, draw a Line towards K, to cut the Line FK at K, which is the Centre, to which the Upright Joints muft point. Then from K through D lay a ftraight Ruler, to cut the Line AB at the Point B, and the Skew-Back *i* B will be had, and defcribe the upper Arch Line AB, by drawing the Lines AF, FB, parallel to C*g*, *g*D, and proceeding to find the Arch AB, as is before taught in *Figure* v. which being drawn, it muft be divided into Courfes according to the Thickneſs of the Bricks or Stones. Then if a Ruler be laid from each Point of Divifion to K, you will mark all the Upright Joints; and the Crofs Joints muft be parallel to the Arches AB and CD.

PROBLEM XLI.

How to work a Semi-Circular Arch in Brick, or Stone.

FIGURE LVII.

FIRST draw the Base-Line A D equal to the Width of the Door, or Window, and twice the Depth of the Arch, and halve it at the Point G, from which Point set off half the Width of the Door, or Window, to B and C, and from G draw the Arches BEC, AFD, and divide AFD into Courses, as in the laſt Problem, and laying a ſtraight Rule from each of the Points of Diviſion to the Point G, you may draw the Upright Joints, and from the Centre G deſcribe the Croſs Joints parallel to the Arches BEC, AFD.

PROBLEM XLII.

How to work a Rampant-Semicircle with Stone, or Brick.

FIGURE LVIII.

FIRST draw the Line A K, and raiſe K D perpendicular to it equal to the Heighth of the Ramp, and draw the Ramp-Line A D, which halve at I, and according to the Directions laid down in *Figure* VII. ſtrike the Arch B F C.

This being done, draw the Arch-Line A E D ſo as to be parallel to the Arch-Line B F C, and at ſuch a Diſtance from it as is the Heighth of the upper Surface of the Arch, which may be deſcrib'd either by gauging from the Arch B F C, or by finding Centres that ſhall anſwer to the two different Sweeps therein; as you may ſee by the Example, where the Point G is the Centre for the Arch F C, and the

Point

Point H for the Arch BF. Now in the Arch-Line AED set off the Thickneſs of the Bricks or Stones (as they are mark'd in the Example) A 1, 12, 34, &c. and from the Diviſions draw the Long or Upright Joints to point to I, by laying a ſtraight Rule from I to 1, I to 2, I to 3, &c. The Croſs Joints are ſtruck from the Centres G, H.

PROBLEM XLIII.

How to work an Elliptical or an Oval Arch, that riſes above a Semicircle, with either Brick or Stone.

FIGURE LIX.

FIRST deſcribe the Arch BFD by the Rule laid down in *Problem* VIII. or by a Tramel. Then deſcribe the Arch AGE parallel to BFD, and at ſuch a Diſtance from it as you deſign the Heighth of the Arch, either by Means of a Tramel, or by the following Rule:

Draw the Line AG, and take CG in your Compaſſes, ſetting one Foot in A, with the other ſtrike the Arch O, and taking AC in your Compaſſes, with one Foot in G deſcribe the Arch *p*, and from the Interſection of theſe two Arches, draw a Line to *i* at Right Angles to the Line AG. This being done, deduct *i k* from the Width of the Surface of the Arch BA, or FG, or DE, and ſet twice the Remainder in the Line *i h* from *k* to *h*, from whence draw the Lines A *h*, G *h*, and divide them each into the ſame Number of equal Parts, and draw the interſecting Lines, which will form the Arch AG. Then you will find *i l* to be equal to BA, or FG, and *k l* equal to *l h*; and ſo of the Arch-Line EG.

The two Arch-Lines AGE, BFD, being deſcrib'd, the Courſes on the Arch-Line AGE muſt be divided, as in the foregoing Examples and this, where they are figur'd E 1, 12, 23, 34, 45, 56, 67, &c. and you muſt find the Joint of each Courſe, by taking a ſtraight Rule, and cutting it off equal to CG, which, when cut to its Length,
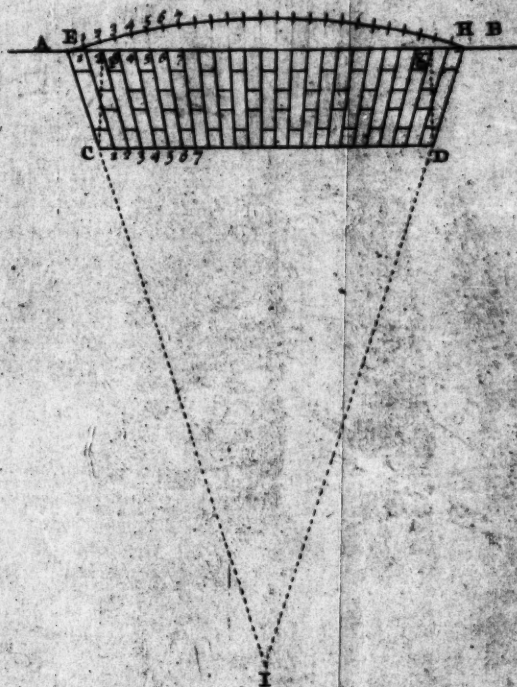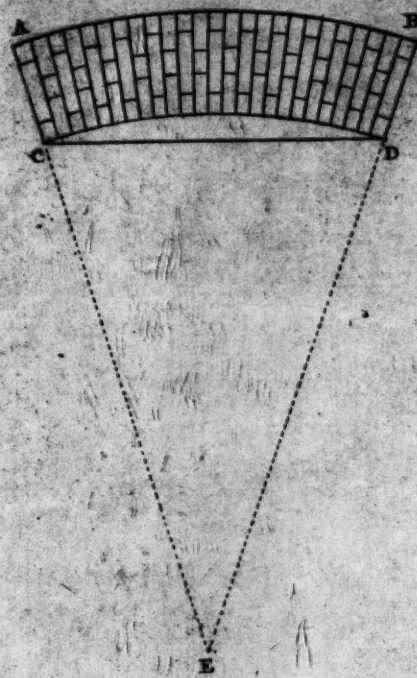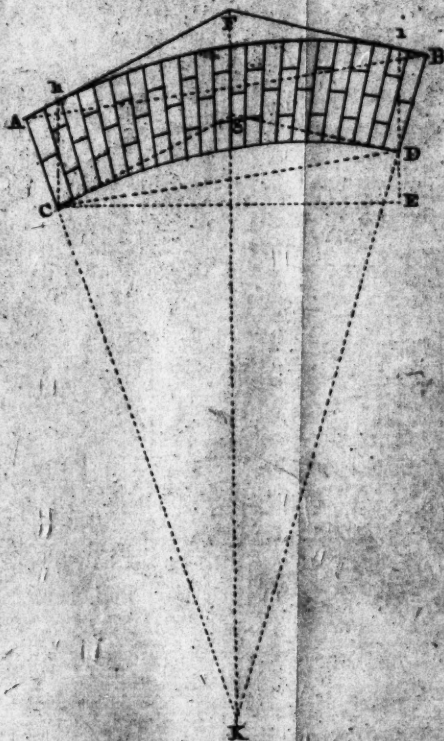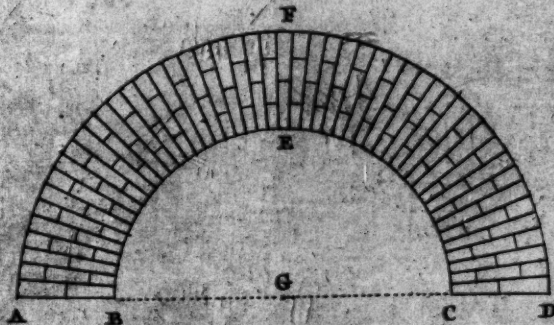
is

Fig. 54.

Fig. 55.

Fig. 56.

Fig. 57.

Plate 8.

is reprefented by the broad Line *m n.* The Rule being ready, take the End *n*, and place the upper Corner thereof to the firft Divifion mark'd 1, and let the upper Corner at the End *m* touch the Line A E, where it fhall fo happen, and along the Side thereof draw the firft Joint; then move the upper Corner at the End *n* to 2, letting the upper Corner at the End *m* touch the Line A E, where it fhall fo happen, and along the Edge thereof draw the fecond Joint; and thus continue till you have drawn them all. And the Crofs Joints muft be drawn parallel to the two Arches by gauging from either of them.

PROBLEM XLIV.

To work an Elliptical Arch, not rifing fo high as a Semicircle, in Stone or Brick.

FIGURE LX.

FIRST draw the Bafe-Line A E, and halve it at the Point G, from which let fall a Perpendicular, of a Length at Pleafure, towards H, after which draw the Elliptical Arch B G D according to the Directions given in *Problem* IX. or X. and defcribe the Elliptical Arch A F E parallel to the Arch B G D thus: Take A B, or D E, and fet it perpendicularly from G to F, and draw the Line F E, and take C F in your Compaffes, and fetting one Foot in E, with the other ftrike the Arch *n*: Alfo take C E in your Compaffes, and fetting one Foot in F, with the other ftrike the Arch *o*, and from the Point wherein thefe two Arches interfect each other, draw the Line to *k* at Right Angles to F E. This being done, deduct *k l* from A B, or D E, and fet the Remainder twice in the Line from *l* towards the Interfection of the Arches *n* and *o*, as to *i*, and draw the Lines F *i*, E *i*, which Lines divide into any Number of equal Parts, and draw the Interfecting Lines, which will generate the Arch-Line E F parallel to the Arch-Line D G. And thus may the Arch-Line A F be generated.

Now fet the Courfes of the Brick, or Stone, on the Arch-Line A F E, and draw the ftraight Joints thus: Take a Ru-

ler

ler, and cut it off equal to A C, or C E, which is reprefented by the broad Line *pq*, and placing the End *q* at 1, the firft Joint, let the End *p* touch the Line C H, where it fhall fo happen, and along the Side thereof draw the firft Joint; then move the End *q* to 2, and letting the End *p* touch the Line C H, where it fhall fo happen, and along the Side thereof draw the fecond Joint, and fo of the others. Then ftrike the Crofs-Joints parallel to the Arch B G D, and the Work is finifh'd.

PROBLEM XLV.

How to work a Rampant Elliptical Arch in Brick, or Stone.

FIGURE LXI.

FIRST draw the Line A *u*, and to A *u* raife a Perpendicular from the Point *u* to E, equal in Length to the Ramp of the Arch; and draw the Line A E, and halve it at C, and from C raife a Perpendicular towards F. This being done, defcribe the Arch B G D, according to the Directions laid down in *Promblem* XI, and defcribe the Arch A I E thus: Take B A, or D E, and fet it perpendicularly from G to I, and draw the Lines A I, E I. Then take C I in your Compaffes, and fetting one Foot in A, with the other ftrike the Arch O: Alfo with one Foot in E, ftrike the Arch *s* with the other, and take A C, or C E, in your Compaffes, and fetting one Foot in I, with the other ftrike the Arches *p* and *t*, and from the Interfection of the Arches *o p*, and *s t*, draw Lines to *h* and *l*, cutting the Lines A I, I E, at the Points *q* and *m*, perpendicular to them. Now take the Line *h q* in your Compaffes, and fet it from B towards A, reaching to the Dot in A B, and take the Remainder from the Dot fet A in your Compaffes, and fet it twice in the Crofs-Line from *q*, towards the Interfecting Arches *o p*, to which draw Lines from A and I. Alfo take *l m* in your Compaffes, and fet it from D to the Dot in the Line D E, and take the Remainder from E to the Dot, and fet

it

it twice in the Cross-Line from *m* towards the Interfecting Arches *s t* to *k*, and draw the Lines I *k*, E *k*, each of which divide into the same Number of equal Parts; as likewise the Lines drawn from the Interfection of the Arches *o p* to the Points A and I: Then if Interfecting Lines are drawn, they will beget the Arch-Line A I E parallel to the Arch-Line B G D.

This being done, divide the Arch-Line A I E into the Courfes of Brick, or Stone; and from the Divifions thereof draw the ftraight Joints by a Lath to the Line C F, as in the foregoing Example, *Fig.* LX. and mark the Crofs-Joints parallel to the Arch-Line B G D, and the Work is finifh'd.

PROBLEM XLVI.
How to work a Gothick *Arch in Stone.*
FIGURE LXII.

FIRST defcribe the Arch B E C, according to the Directions laid down in *Problem* XII. and fet off the Width of the Arch A B, C D, and draw the Out-Lines D H, H F, parallel to the Lines C G, G E, wherein fet the equal Divifions, and draw the Interfecting Lines, which will generate the Arch-Line F D parallel to C E. Then by by *Problem* III. find a Centre anfwering as near as poffible to the Arch C E, which fuppofe to be where the two Arches *l* and *m* meet, and this will be that towards which the Joints muft point; and in like manner, the Interfection of the two Arches *i, k*, is nearly the Centre of the Arch-Lines A F, B E. This being done, fet the Courfes on the Arch-Line A F D, and then draw the Joints pointing to the Interfections of the Arches *k i* and *l m*.

PROBLEM XLVII.

How to work a Gothick *Arch in Brick, or Stone.*

FIGURE LXIII.

FIRST draw the Arch BFD, according to the Directions laid down in *Figure* XIII, and set off the Width of the flat Surface of the Arch A B, DE. Then draw the Out-Lines parallel to each other, as in the foregoing Example, and describe the Arch AGE by the Intersections of Lines, which will be parallel to the Arch-Line BFD; upon which set the Courses, and draw the straight Joints pointing to C; and the Cross-Joints must be parallel to the Arches AGE, BFD, and the Work is finish'd.

PROBLEM XLVIII.

The Centre whereon the Arch of a Bow-Window is turn'd being given, how to find another Centre that shall answer parallel to it, according to the upper Edge of the Surface of the Arch.

FIGURE LXIV.

FIRST describe the Arch BKC, according to the Directions laid down in *Problem* XXVIII. and set the Width of the flat Surface of the Arch from B to A, and from C to D; and draw the Lines AD, BC, and halve them at F and E, from whence draw a Perpendicular of a Length at pleasure to H. Then in any convenient Place (*Figure* LXV.) draw a Line at pleasure, as from A to G, and from A draw to AG the Perpendicular AF. Then take EI, in (*Figure* LXIV,) and set it from A to B, (*Figure* LXV.) and EI from A to C. This being done, take the Semi-Diameter BE, or EC, (*Figure* LXIV.) and set it from A
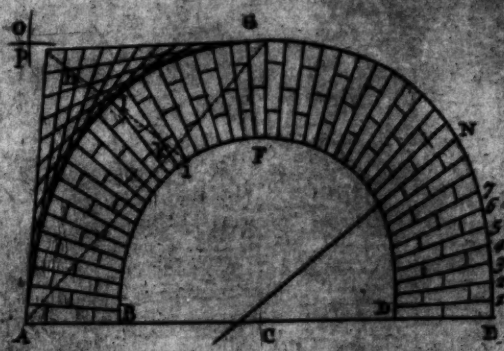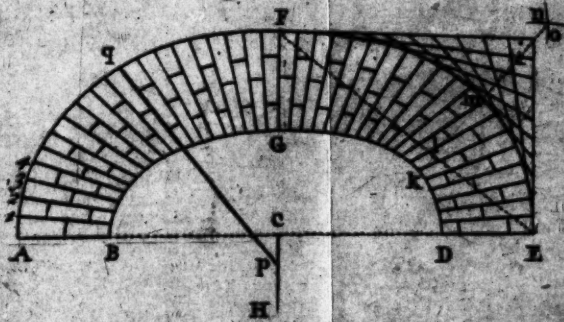
to

Fig. 58.
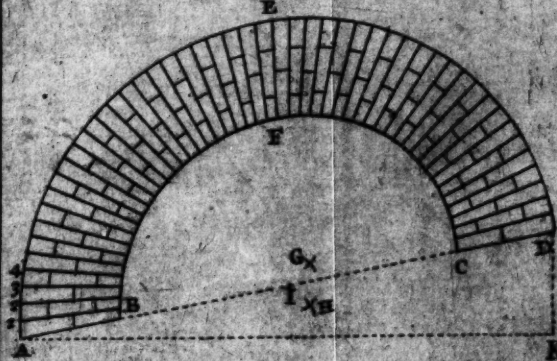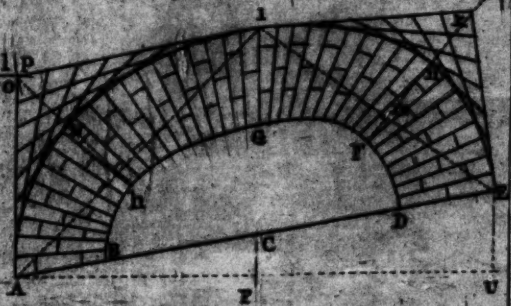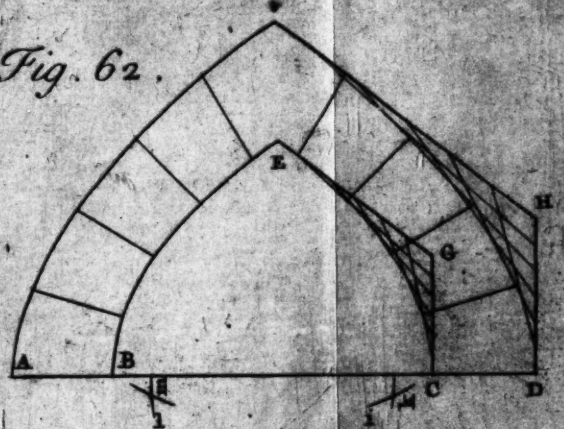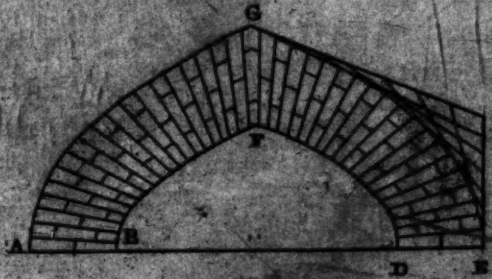
Fig. 59.

Fig. 60.

Fig. 61.

Fig. 62.

Fig. 63.

Plate 9.

to D, (*Figure* LXV.) Alſo take A B, or C D, and ſet it from D to E, and draw the Line EC, which ſet in the Line EH from E to *g*. Again, take the Width of the flat Surface of the Arch A B, or C D, and ſet it in the Line EH, from K to 7, and divide the Remainder from 7 to 9 into ſeven equal Parts. Alſo divide the Arch B K into ſeven equal Parts. Then take K 1, in the Line EH, between your Compaſſes, and ſetting one Foot in 1, with the other ſtrike the Arch 1 at pleaſure: Then take K 2, and ſtrike the Arch 2: Alſo take K 3, K 4, K 5, and K 6, ſeverally, and ſtrike the Arches 3, 4, 5, and 6. When this is done, open your Compaſſes, and divide from A to *g*, keeping the Points of them on thoſe Arches, till you have gotten ſeven equal Diſtances from A to *g*; at the Points of which, if Nails be ſtuck in, and a thin Rule be bent round them, from A to *g*, along the Edge thereof the Arch A*g* may be drawn. And in like manner may the Arch D*g* be drawn.

PROBLEM XLIX.
How to work a Nich in Brick.

FIGURE LXVI, LXVII.

FIRST deſcribe the Semicircular Arches A I G, and B H F, and draw the Courſes pointing to the Centre, and from the Courſes in the Arch-Line B H F, draw Lines to the Centre, to repreſent the Joints of the Nich; and deſcribe the Crown *c e* according to the Thickneſs of the narroweſt Part of the Courſes. Then take a Piece of Plank, as is repreſented in *Figure* LXVII, and upon it draw a Quadrant *b d*, equal to B H or F A, and cut the End *a b* off, to anſwer the End A B in *Fig.* LXVI, and ſet the Thickneſs and Summering of the Brick, mark'd 2, on the End thereof; ſo that 2 and 2 are equal to each other. This being done, plane the Piece to its Thickneſs, at the End *a b*, gradually to nothing at the Point *d*; and take *c* D, *Figure* LXVI, which is half of the Diameter of the Crown, and ſet it from *d* to *e*, and lay a ſtraight Rule from *c* through *e* to *f*,

N and

and cut the Piece off at *e f*. Then does the Mould *a b f e* anſwer to every Courſe in the Nich. And mark the Croſs Joints upon them, ſetting one Foot of your Compaſſes at D, according to their Brackets on the Edge of the Mould, whereon you have all the Bevels, Lengths, and Thick-neſſes.

PROBLEM L.

How to work a Level Arch in a Circular Wall.

FIGURE LXVIII.

FIRST ſtrike the Sweep A D, repreſenting the Wall wherein the Arch ſtands, and thereon ſet B C, the Width of the Door or Window. Then draw the Lines B I, C I, and ſet the Width of the Surface from B to *l*, and from C to *m*, and ſtrike the Arch *l m* from I. This being done, ſtrike the Arches E F, G H, from the ſame Centre, after the ſame Manner as the Arches B C, *l m*, only letting them be ſo much the longer, as are the two Skew-Backs of the Arch ; then halve B C at N, and E F at O, and ſet the Mould E F G H, perpendicularly over the Mould B C, *l m*, and ſo much above it as you deſign the Surface of the Arch ſhall riſe, the Point O being perpendicular over N. Then on the Centre I raiſe a Perpendicular to K, letting I K be equal to N O.

This being done, ſet the Courſes on the Arch E F, ac-cording to the Thickneſs of the Bricks, or Stones, you work with. Alſo divide the Arch B C into ſo many equal Parts, as E F, which give the Thickneſs of each Courſe at the Bottom of the Arch. Then ſtrain a Line, or lay a ſtraight Rule from the Perpendicular at K to the Divi-ſions or Joints of each Courſe on the Arch E F, beginning at E or F, and draw Lines to the Arch G H, ſhewing the Summering at the Top of each Courſe, according to the Sweep of the Wall. Again, draw Lines from the Divi-ſions of the Arch B C, to the Arch *l m*, pointing to I, which ſhews the Summering of each Courſe at the Surface; and ſo
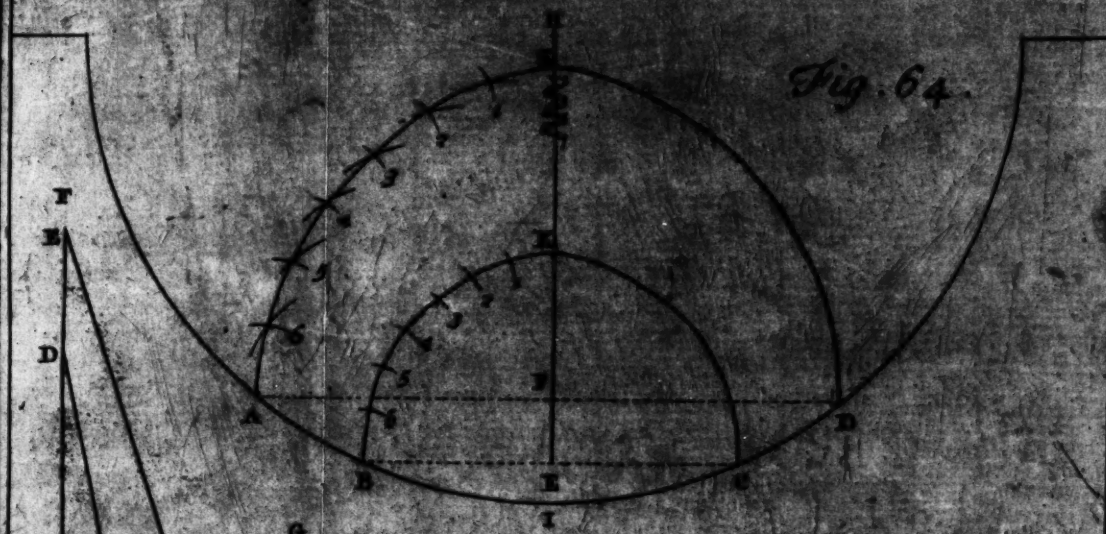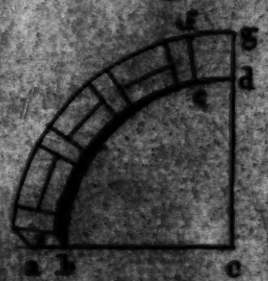
you

Fig. 64.

Fig. 65.

Fig. 66.

Fig. 67.

you have the Width and Summering of the Mould given for the Surface of each Course on the two Arches E F, B C.

But the Cross-Joints are found thus: Take a Bevel, whose Stem is long enough to reach from C to F, and set thereon, placing the Blade to the Arch E F towards O ; and this gives you the Cross-Joints for the first Course. Also set your Bevel on the Next Divisions to C and F, and place it after the same Manner, for finding the Cross-Joints in the second Course; and so of the rest.

PROBLEM LI.

How to work an Arch for a Bow-Window in Brick or Stone, which is a Semi-Circle, and swells a Scheme.

FIGURE LXIX.

FIRST describe the Sweep A F, to represent the Wall wherein the Door or Window stands, and set on the Width C D, B E. Then erect a Perpendicular O *t*, on the Centre O of the Arch A F, and strike the two Central-Arches B *s* E, C *z* D, to answer the Out-Lines of the Tops and Surface, by the Rule laid down in *Problem* LXIV. Which when done, put them into their due Position, letting *z* and *s* be perpendicularly over *q*. Then will Q *z* be equal to the Semi-Diameter of the Window, and divide the Courses on the Arch B *s* E, according as they are Brick or Stone, and divide the Arch C *z* D into the same Number of Parts as B *s* E. This being done, take a small Line, and strain it from the Centre O to C, bringing it round on the Surface to B, and from B to O again. Then take the Heighth from the Line C D, to the first Division on the Arch C *z* D, at *z* and set it up perpendicularly from O towards *t*; from whence strain the Line to 1, bringing it round on the Surface to 2, from whence strain it level to the Perpendicular again. Then take the Heighth from the Line C D to 3, and set it up perpendicularly from O towards *t*; from whence strain a Line to 3, and bring it round on the Surface to 4;

from

from whence ſtrain it level to the Perpendicular again, and ſo on. As may be ſeen by the Courſes *m p*, and *g n*, letting the Lines remain on the Centres and Perpendiculars, that give the Summering, Twiſtings, and Bevels, of every Courſe, from whence you are to make the Moulds, and take the Bevels.

Note, The Point O muſt be level with BCDE; and alſo the Lines that are ſtrain'd from the Perpendicular to the Centre.

PROBLEM LII.

How to work a Regular or Irregular Groin in Brick or Stone.

FIGURE LXX.

REPRESENTS the Centre for an Irregular Groin, where KL is ten Feet, and OH eight Feet. Divide the Backs or Circumferences OQH, KFL, into any equal Number of Parts, according to the Thickneſs and Quantity of Courſes contain'd on the larger Centre KFC. Then will the Diviſions or Thickneſſes of the Courſes on the leſſer Centre OQH be ſomething thinner, and your Bricks or Stones muſt be provided accordingly, and ſo you will prevent dropping of Courſes. This being done, on thoſe Diviſions ſtrike Chalk-Lines, which are repreſented in the Example by Prick'd Lines; and theſe are the true Guides by which the Courſes muſt be work'd level, and alſo to take the Bevels of the Groin.

Having done this, begin to work the firſt Groin-Brick after the following Manner: Take the Bevel 1 on the Centre, and ſet it on the Edge of the Brick R, and from the Bevel ſtrike a ſquare Stroke on each flat Side of the Brick, to which cut the Bevels of the firſt Brick. For the ſecond Brick, ſet the Stem of the Level 2 on the firſt Line, and the Blade thereof to the Arch or Curve of the Centre, and this Bevel ſet on the Edge of the Brick D: Then take the Bevel 4, and ſet the Stem to the ſecond Line 3, on the

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Fig. 68.

Fig. 69.
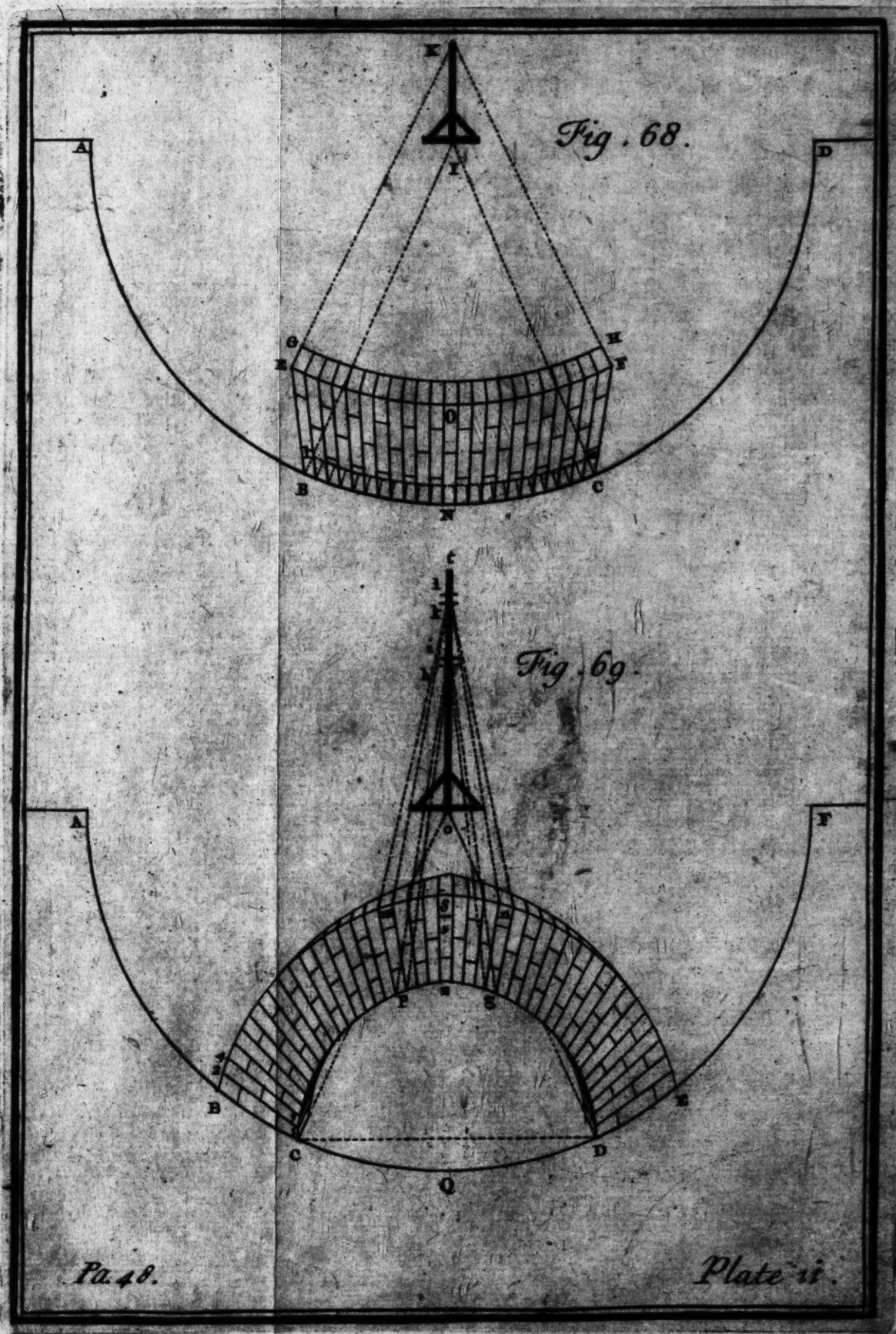
Plate ii.

fame Centre, turning up the Blade on the other Centre, to anfwer the Summering of the fecond Courfe, which Bevel fet on the upper Side of the Brick D from the Bevel 2; to which cut the Bevels of the fecond Brick, and place it in its Pofition, and you will find that it does not anfwer the Summering of the Courfe on the reverfe Centre; to do which, make a Mark on the Brick where it touches the fecond Line on the reverfe Centre, and fet back the Width of a Courfe from that Mark to the upper Edge of the Brick where it fhall fo fall out, and from thence ftrike a Line to the firft Mark at the fecond Line, as alfo to the upper Corner of the Brick at the Curve of the Centre, to which cut the fecond Brick, (according as they appear in the Examples C and E,) which anfwers the Summering of both Courfes; and obferve that as much as you take off from the upper Side to anfwer the reverfe Courfe, fo much you muft add to the under Side by a Clofier, the Figure whereof appears in the Example F; which, if fimmer'd to the Brick, will add much to the Strength and Beauty of the Work.

Now find the Bevels and Summering of the third Brick thus : Set the Stem of the Bevel 3 and the Blade to the Curve of the Centre, and then fet the Bevel on the Edge of the Brick B, which done, take the Bevel 4, and fet it on the third Line, on the fame Centre, turning up the Blade thereof on the reverfe Centre, to anfwer the Summering of the Courfe, which fet on the flat Side of the Brick B, from the Bevel 3; to which Bevels cut the third Brick, and place it in its Pofition; then make it to anfwer the Summering of the reverfe Centre, as has been before taught, by marking the Brick where it touches the Level-Line on the Centre, and cutting back the Width of the Courfe, and cut the Clofier accordingly. And thus proceed on till you have gone fo far with your Groin, that the Summering turns up the Brick its whole Thicknefs above the Level-Line; and then the Remainder of the Groin muft be all Headers and Clofiers ; but the Bevels are taken the fame. Only obferve that inftead of placing the Stem of the firft Bevel on the Edge of the Brick, you muft place it on the End, as in the Example on the Brick N fhews, and fo on ; obferving that as your Clofier increafes in Thicknefs, from no-

O　　　　　　　　thing

thing at the Springing, so it must decrease to nothing at the Crown. And thus any Regular or Irregular Groin may be work'd.

Figure LXXI. shews the Inside of the Groin after it is finish'd; where you may see by the Closier the Summering of each Course, and the Bevel of every Brick.

PROBLEM LIII.

How to diminish a Column, or Pillaster.

FIGURE LXXII.

WHEN the Heighth and two different Diameters of the Column are given, proceed thus: Divide the whole Heighth into three equal Parts, and draw the first third Part from A to B, perpendicular to the Base; and from B draw a Cross-Line parallel to the Base; upon which describe a Semicircle, having its Diameter equal to the Diameter of the Column below. Then draw a Line down the Middle of the Column, or Pillaster, as DE perpendicular to the Base.

This being done, take half of the Diameter of the Column above, and set it both Ways parallel to the Base, from the Middle Line ED to the Arch of the Semicircle before described, where it shall so happen, as at 66; and divide that Part of the Circle from the Springing of the Arch to the Points 66 into any Number of equal Parts, as six, and draw Lines parallel to the Base, to the correspondent Divisions on each Side the Circle as 11, 22, 33, 44, 55, 66. Then divide the upper Part of the Column, from B to the under Side of the Astragal on the Neck of the Column into the same Number of Parts as you did that Part of the Arch between the Springing and the Point 6, which is 6, and at each Division draw Lines a-cross at Right-Angles to the Middle-Line ED, and take half the Line 11 in the Circle, that is, from the Middle to 1, either Way, and set it both Ways on the Line 11, upon the upper Part of the Column. Moreover, take half the Line 22,
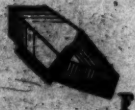
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Fig. 70.
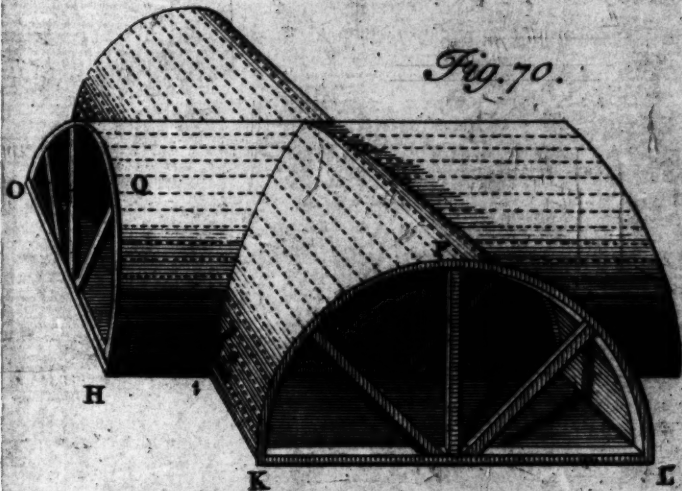
Fig. 71.

on the upper Part of the Column, and so on; and the six Lines in the Circle are equal to the six Lines on the Part of the Column; and in the extreme Points stick Nails, and bend a thin Lath round them, so that it touches each of them; then with a Pencil, or any other Marker, describe the swelling Part of the Column that is generated by the Circle, which, when drawn upon a Board, is a Mould to work by.

PROBLEM LIV.

How to work a Diminishing Pillaster in Brick.

FIGURE LXXIII.

FIRST make a diminishing Rule to fit the whole Side of the Column, or Pillaster; and if it be large, so that a Board will not reach the whole Length, you must make it several Lengths, always observing to keep the Rule in its proper Place, according to what Part of the Column it belongs, then begin to work. The Example F is the first Course, and the Example G the second, and those continue perpendicular all of the same Bigness to one third Part of the Heighth of the whole Column, that is, from the Base to the Course A B, and from thence it diminishes something to the Collar of the Capital; the Out-lines being drawn according to the Rule in the foregoing Problem, divide your Courses all of one Thickness, and divide the breaking Joints, so that they be parallel to the Out-lines as in the Example; as the Course A B consists of two Streachers and one Header, which is the half of a Streacher, and must be divided into five equal Parts, being two to each Streacher, and one to the Header, and so of the Courses *e f, i k, p q,* and *t u,* they bearing the same Proportion to each other, tho' they are shorter, by reason of the Diminishing. The Course *c d* consists of two Headers, one Streacher, and two Closiers, and must be divided into ten equal Parts, because two Closiers are equal to one Header, and four are equal to a Streacher. Understand the same of the Courses *c d, l m, no,*

and

and *rs,* they all bearing a Proportion to each other, after the like Manner. Then upon those Divisions, whereon the Joints are to come, as may be seen by the Dots in the Example, stick in small Nails, and, as in the last Problem, bend a thin Rule about them, and with a Marker describe the Cross-Joints, which will diminish parallel to the Out-lines.

PROBLEM LV.

How to work a Diminishing Column in Brick.

FIGURE LXXIV.

FIRST describe the Out-lines of the Column, and the Thickness of the Joints, as in the foregoing Example, and draw the Plane of each Course, as *hi,* from whence the Arch, Diminishing, Length, Width, and Bevel, of each Brick is found. One Third of the Column from *ab* to *ab* is perpendicular, and from *b* to *h,* it is somewhat swelling, according to *Figure* LXXII. therefore you must work thus :

Rub the Bricks all to one Thickness, and take a Block just the Thickness of the Bricks you work, and about three Inches square, and set the Centre thereof just over the Centre of each Plane, and nail small Fillets about it, on the Board upon which the Plane is drawn, to confine it in its Place without nailing it down, because hereafter you will have occasion to take it off, and set it on at every Brick you work, the Use thereof being to raise equal to the Heighth of the Brick ; so that you shall strike the Arch and Bevels thereof without Moulds, which would be troublesome in the diminishing Part of the Column ; but in the perpendicular or upright Parts, you may work with Moulds taken from the Planes, because one serves for all of that kind. But I shall proceed thus :

Take the first Brick, and lay it upon the Plane of the Brick 12, in the Plane *h;* then take half the Diameter of the Pillar, or Column, in your Compasses, and set one Foot in

the

the Centre on the Block, and with the other ſtrike an Arch on the flat Side of the Brick to anſwer the Outſide of the Column. This being done, take the Diſtance 12, 23, or 34, and ſet it upon the Brick or the Arch, and on the extreme Points lay a ſtraight Rule to the Centre *h*, and along the Side thereof mark the Joint or Summering of the Brick; then take it up, and from theſe Joint-Strokes ſquare over the Edges thereof to find the Joint-Strokes on the other Side of the Brick, upon which draw the Joints or Summering; as alſo an Arch equal to the former, by ſetting the former one firſt to fit on the Arch of the Plane. Then, with your Compaſſes opened to the ſame Diſtance as before, ſetting one Foot in the Centre on the Block, with the other ſtrike an Arch on the other Side of the Brick. Then you will have the Joints, Arch, and Summering of the Bricks, and ſo of the reſt, &c.

Now work the diminiſhing Part of the Column thus: Firſt take off the Block, and then take half of the Diameter of the Column at the Joint 1 in your Compaſſes, and ſetting one Foot in the Centre *h*, with the other ſtrike a Circle within the Circle of the Plane, which Circle Mark 1: Alſo take half the Diameter of the Column at the Joint 2, and ſetting one Foot in the Centre *i* in the Plane *i*, with the other ſtrike a Circle equal thereto. Moreover, take half the Diameter at the Joint 3 in your Compaſſes, and ſetting one Foot in the Point *h*, in the Plane *h*, with the other deſcribe a Circle. Again take half the Diameter of the Joint 4 in your Compaſſes, and ſetting one Foot in *i*, with the other deſcribe a Circle, and ſo on; alſo deſcribe a Circle, whoſe Diameter ſhall be equal to 5 in the Plane *h*, and a Circle whoſe Diameter ſhall be equal to the Joint 6 in the Plaue *i*, and ſo of 7 and 8, and the reſt to the Capital of the Column; and always obſerve to draw the Circle that repreſents the under Side of each Courſe in the Plane to which it belongs, that is, if it be all Streachers to *h*, if it be Headers, Streachers, and Cloſiers to the Plane *i*.

Having the Circles all drawn to repreſent the under Side of each Courſe, ſet the Block in its Place, and begin to work the diminiſh'd Courſes mark'd thus: Take a Brick, and lay it upon the Plane, as is taught before; then take half of the Diameter of the Circle 1, in the Plane or the Joint 1, on the Column, in your Compaſſes, and ſetting

P   one

one Foot in the Centre *h*, on the Plane *h*, with the other strike an Arch on the Brick, to represent the Outside of the Column of the Joint 1. This being done, lay a straight Lath from the Centre *h*, on the Block, to the Point, letting it lie perpendicular over the Line 1 *h*, and along the Edge thereof strike the Joint or Summering of the Brick; also lay a straight Lath from the Centre *h* to 2, perpendicularly over *h* 2, and turn the Brick upside down, and set the Arch and Cross-Joints just on the Arch and Cross-Joints of the Arch 1 in the Plane *h*; then take half the Diameter of the Arch 2 in the Plane *i*, or half the Diameter of the Column at the Joint 2, and setting one Foot in *h*, with the other strike an Arch on the other Side of the Brick, and mark the Joints or Summering of the Brick as before, by laying a straight Rule from the Centre *h* to 1 and 2. This being done, cut the Arch on the Brick to represent the Outside of the Column; which, when done, draw the Cross-Joints on the outward Edge of the Brick from the Lines on each flat Side thereof, which cut to these Lines, and you will find the Brick and Joints to answer the true Diminishing of the Column. Understand the same for the rest of this sort of Courses.

To work the Courses mark'd 2, take a Brick, and lay it end-ways upon the Arch 2 in the Plane *i*, at 4 and 5, and keeping the Compasses at the same Distance as when they struck the Arch on the upper Side of the Brick mark'd 1, in the Plane *h*, which is half the Diameter of the Circle 2, or Semidiameter of the Column at the Joint mark'd 2, and setting one Foot in the Centre *i*, with the other strike an Arch on the upper Side of the Brick; then lay a straight Rule from the Centre *i* to 5, and strike the Summering of the Brick. Moreover, as before taught, turn the Brick upside down, and set the Arch and Summering Stokes or Joints of the Brick to the Arch 2, and the Cross-Lines 4, 5. This being done, take the Semidiameter of the Circle 3, that is, the Semidiameter of the Column at the Joint 3, and resting one Foot in the Centre *i*, with the other strike an Arch upon the upper Side of the Brick equal thereto. Then, as before, lay a straight Rule from the Centre *i* to 4 and 5, and upon the Edge thereof set on the Summering Joint, upon the upper Side of the Brick. When you have done this, cut the Arch on the End of the Brick, as also
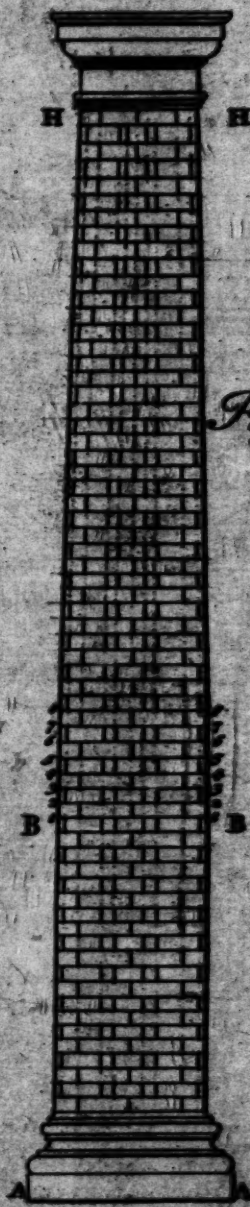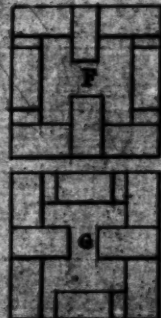
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Pl. 13.
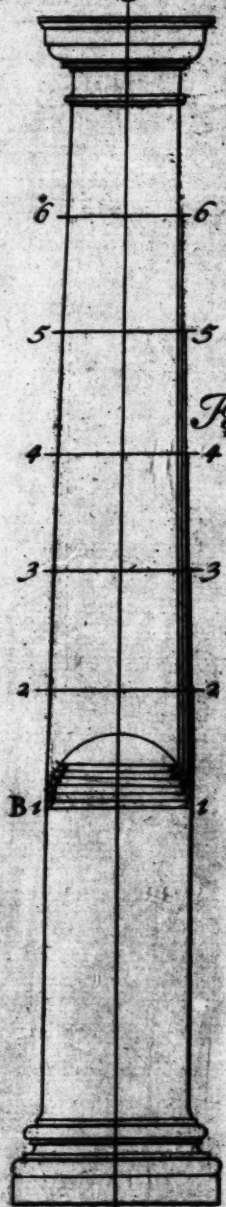
Fig. 72.
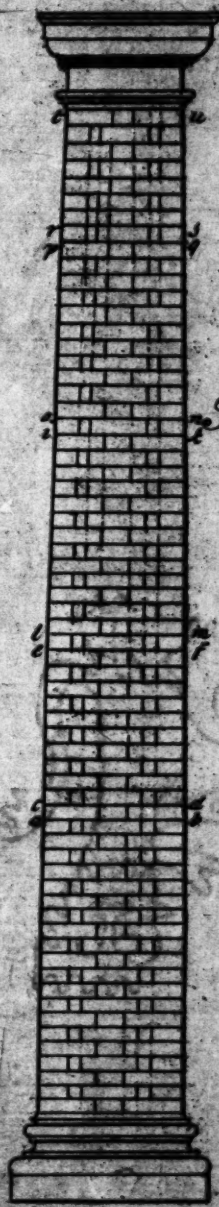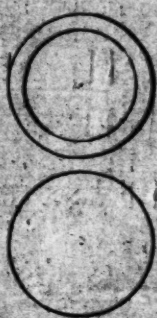
Fig. 73.

Fig. 74.

the Summering Joint, which, when done, is a Header to the Course mark'd 2, and anſwers to the diminiſhing and true Joints of the Work, the Streachers and Cloſiers being mark'd after the ſame Manner; and ſo of the reſt of the Courſes which when done, the Work is finiſh'd.

N. B. The Circles, mentioned in the foregoing Problem, are not inſerted, becauſe the Scale being ſo ſmall would not contain them; and obſerve to number them as the Joints on the diminiſhing Part of the Column, becauſe they are equal to each other.

PLATE XIV.

REpreſents two Raking-Collonadoes on the Side of a Hill, wherein Walks are cut; and they are here inſerted only to ſhew the Uſe of Raking-Arches, ſuch as may be ſeen on the Side of *Richmond-Hill,* leading to the old Wells.

PLATE XV

Repreſents three Flights of a Stair-Caſe with the Ceiling under the Gallery, or Landing-Place, under which the Point of Sight is taken; and they are here repreſented to ſhew the Uſe of the following Machine in *Plate* XVI. which is to turn Raking-Mouldings, Balliſters, or any other Raking-Work of that kind, which, in my Opinion, would be very beautiful in this kind of Stairs, to have the upper Mouldings next to the Hand-Rale, to rake equal thereunto, but the lower Mouldings next to the Step to be ſquare anſwerably.

FIGURE LXXVIII.

IS the Machine, the Nature of which may be ſeen at one View, by lifting up the Handle of the Bow wherein the Swivle of the Crane turns, which will cauſe the Socket thereof to turn out of a Perpendicular, the Swivle to which the Balliſter is faſten'd, being let therein muſt conſequently draw too and fro, ſo much as the Crane turns out of a Perpendicular : Therefore ſo much as the different Mouldings rake, you muſt lift the Handle higher

or

or lower accordingly; and if you have occasion to turn Square-Work, move the Handle down to the Bottom of the Mortise, and then your Work will be level, and turn perpendicular. The different Parts of this Machine are put together in the following Manner: The two Gaugings of the Bow A are let into two level Pieces on each Side the Puppet-Head, so that the Eyes in which the Spindle of the Crane turns are level with the Spindle to which the Ballister is fasten'd, and the Bottom of the Mortise in the Puppet-Head must be level with the Gaugings of the Bow. The Eyes BB frame into the Plate of the Bow A, and CC are the Keys to fasten them. On the under Side D is the Swivel which goes thro' the two middle Puppet-Heads; the one End fits to the Socket of the Crane, and the other to the Box that fastens the Ballister. E is the Box which screws on to the End of D; *f* is the Nut to fasten it on; and *g g* are the Screws that fasten the Ballisters into the Box E. H is the Mandrel that goes thro' the Puppet-Head, whereon the End of the Ballister turns, by boring a Hole in the End of the Ballister something deeper than the Rake of the Mouldings, because of its sliding to and fro. I is the Spindle of the Crane that is let into the two Eyes BB; and *k* is a round Nut that fastens the Spindle I into the two Eyes BB. L is the Draught of the Ballister which all Turners must have before them, to find the Rake of each Moulding. M is the Socket in which the End of D goes; the upper Hole thereof must be a very little bigger than the End of the Spindle, and the lower End must be so large, that when the Handle of the Bow is lifted up to the Top of the Mortise, the Inside of the Hole shall be perpendicular.

FIGURE LXXIX

Is the Plane of the Lath; and N, O, P, Q, are the Mortises wherein the Puppet-Heads stand.

FINIS.

Fig. 75.
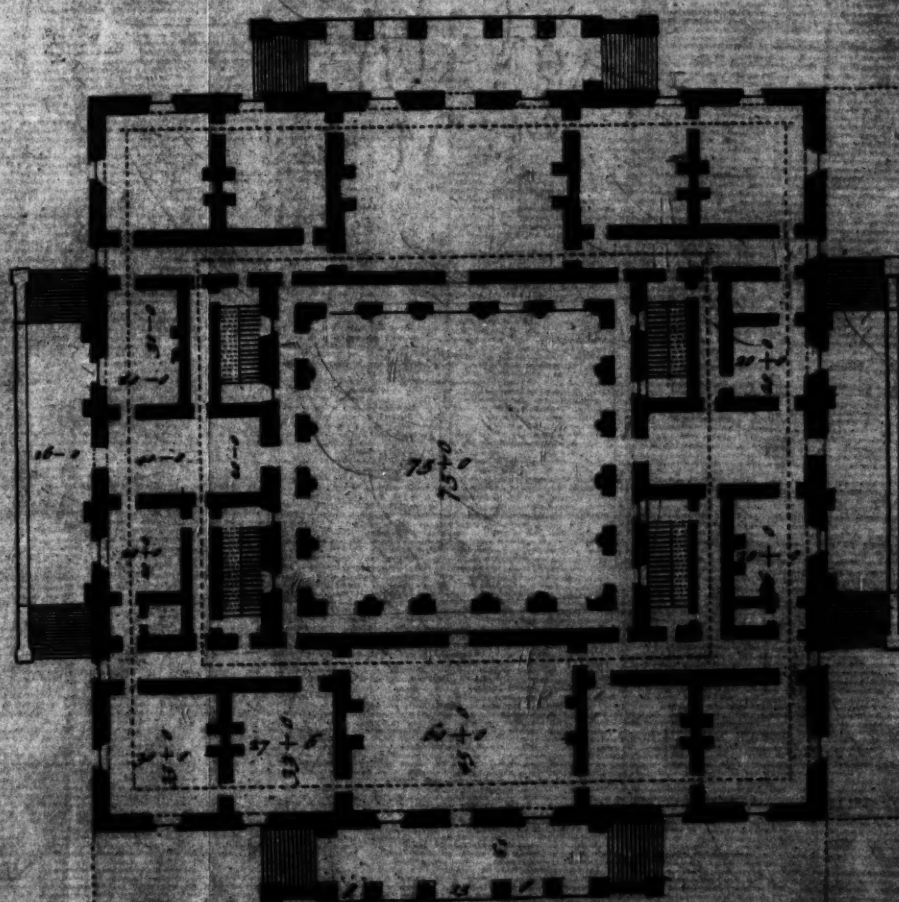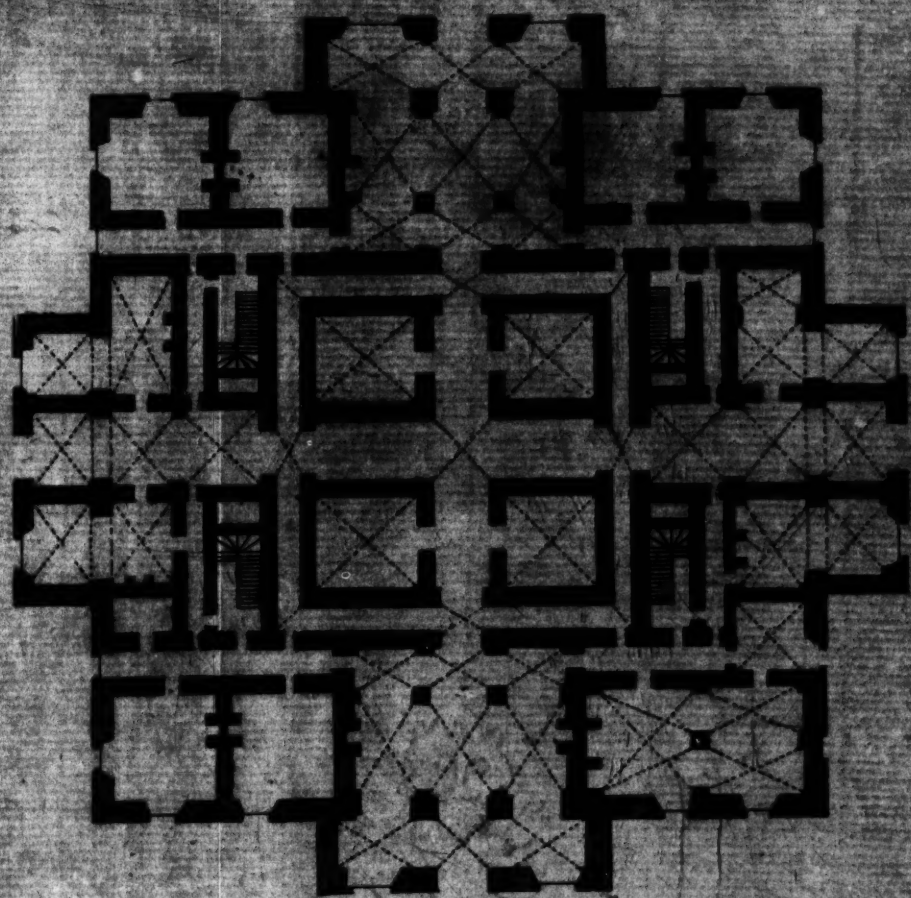
Fig. 76.

Fig. 77.
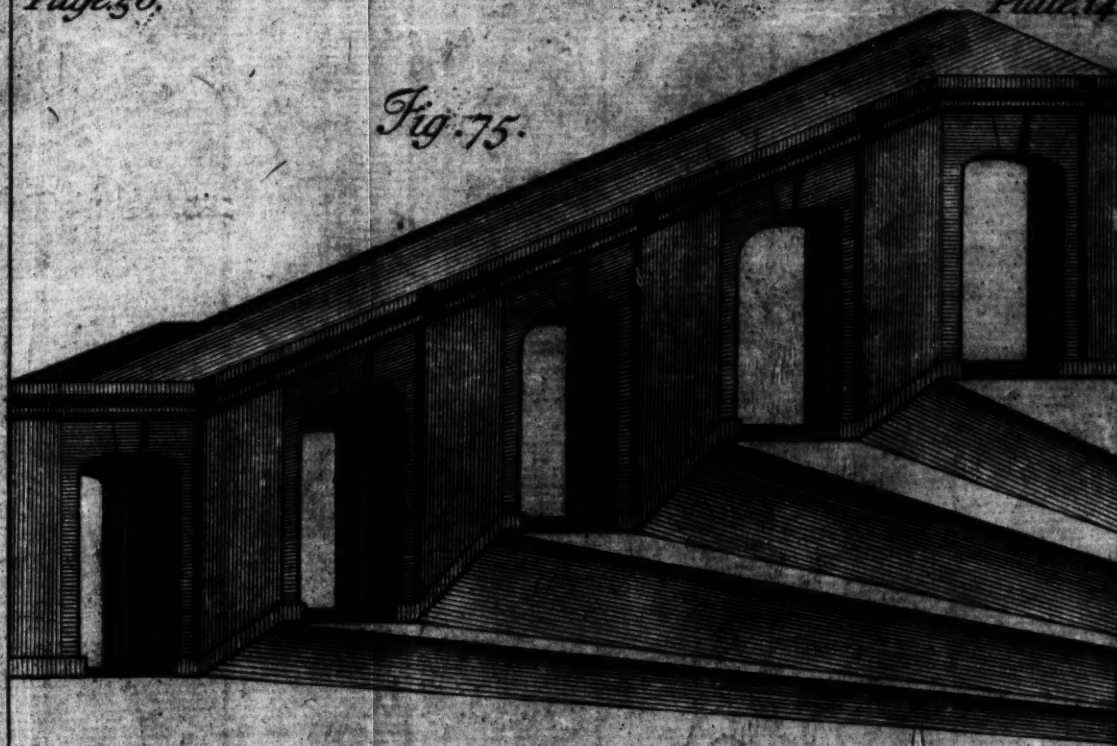
Plate 15.

Pl. 16.
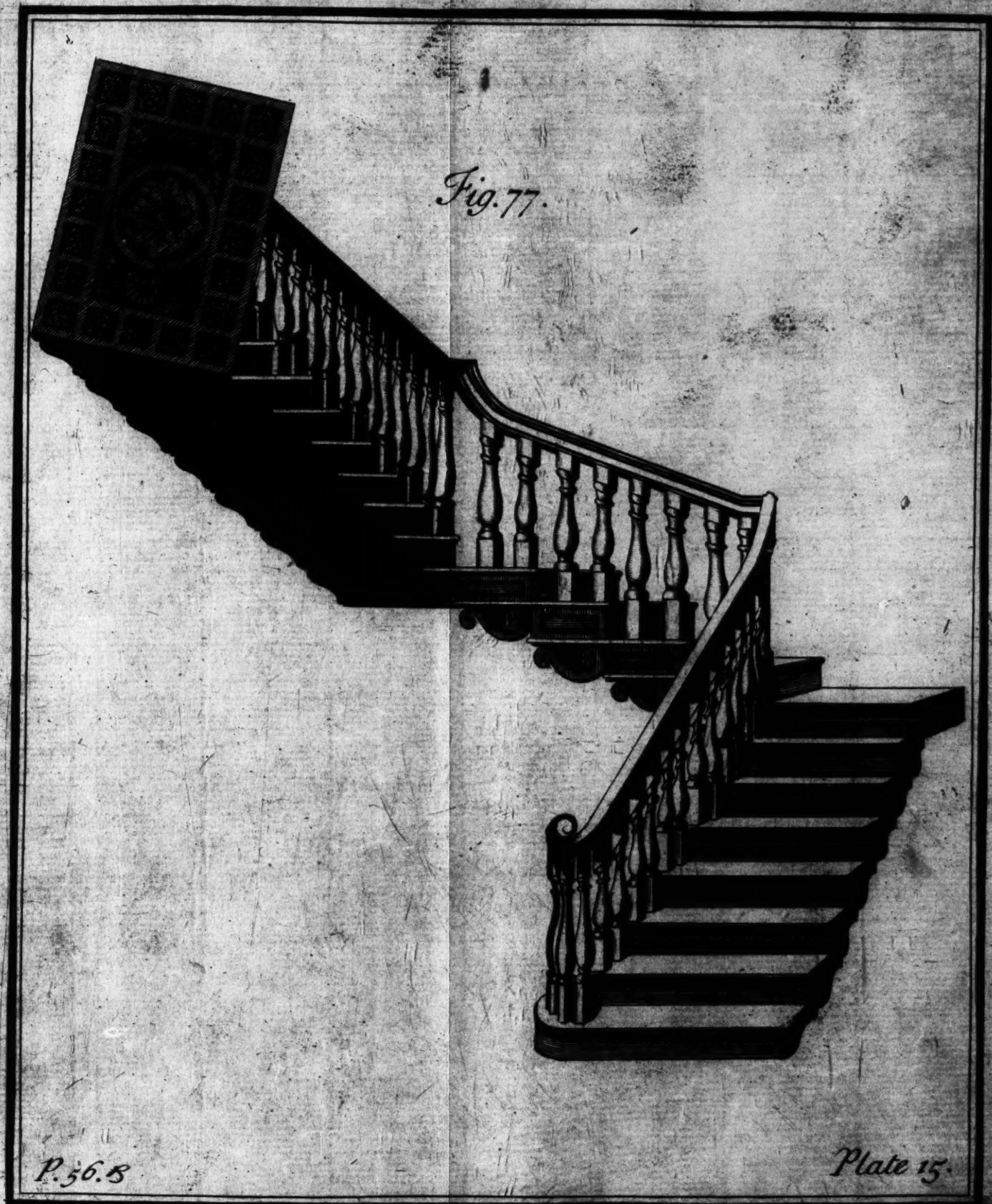
Fig. 78
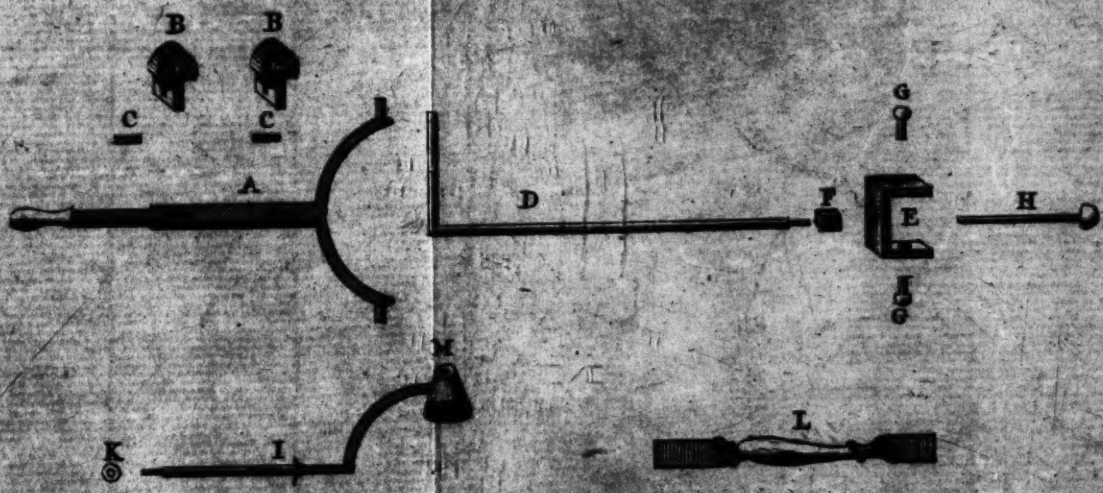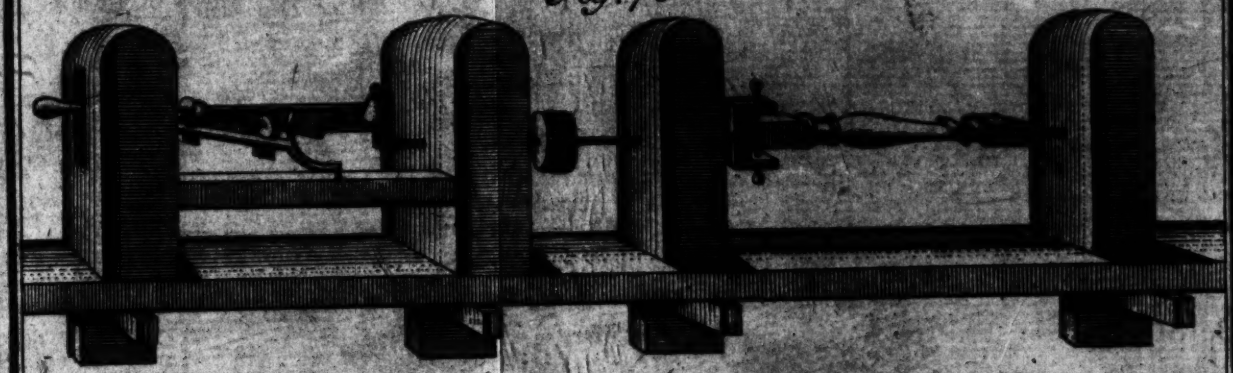
Fig. 79
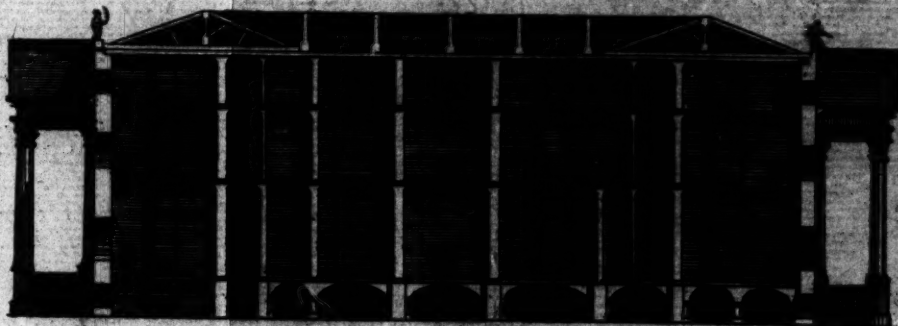
Plate 17.

The ELEVATION, & SECTION, of a HOUSE of my INVENTION.
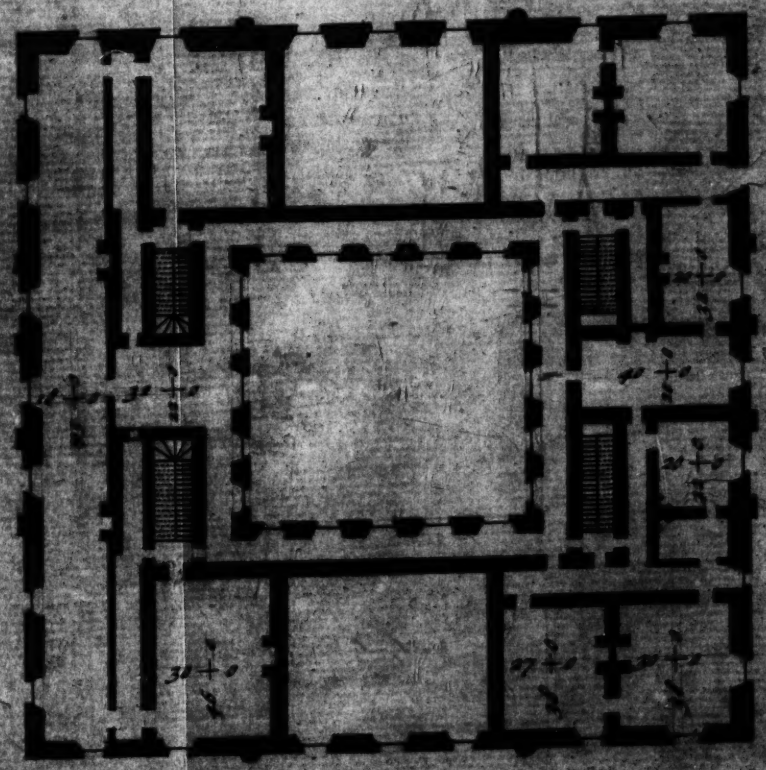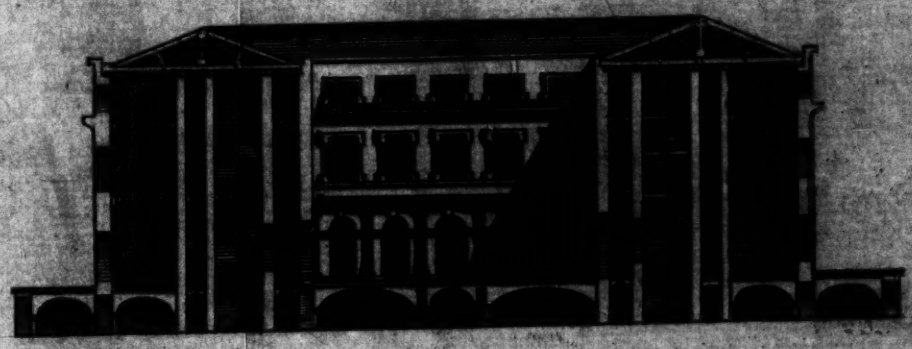with ÿ PLANS, & SECTION, as in the following Plates

Pl. 18.

The Seller, and first Floor Plan.

Plate 19.

The Chamber Plan, and Section.

ERRATA.

PAGE 5. Figure VII. Line 4. read *as are drawn in Figure* VI; p. 7. l. 1. r. *Line* CE, *which halve in the Point* D; p. 10. Fig. XV. l. 5. r. *Then taking* CE; p. 12. Fig. XVIII. l. 1. r. *halve it at* C; ibid. l. 5, & 6. dele the Words *and draw the Lines* AD *and* BF; p. 13. l. 7. r. *Scheme under a Semicircular Arch*; p. 15. Fig. XXI. l. 7. r. *Lines* AG, *and* DH *perpendicular to* AD; p. 16. Fig. XXII. l. 8. r. AG *and* DH; p. 18. l. 9. r. lg; ibid. l. 10. r. *Line* f l; p. 19. Fig. XXV. l. 2. for *equal* r. *unequal*; p. 20. l. 4. r. *Lines* OP, ST, VZ, LM, *and* I K; ibid. Fig. XXVI. l. 6. r. *Arch* v z t; p. 22. l. 15. r. *Lines* z n, n k, *and* o k; p. 23. in the two last Lines but one of Fig. XXVIII. dele *drawn from the Extremities of the Perpendiculars*; p. 28. l. 22. r. *Arches* p *and* q, *over* E; p. 29. l. 4. r. DR for DK; p. 30. l. 5. r. *as* AH; ibid. l. 15. for *baste* r. *baste*; ibid. l. 21. r. lh *from* o *to* k; id. ibid. for *baste* r. *baste*; p. 31. Fig. XLII. l. 7. r. *Lines* aG, ah, aO, *are drawn*; p. 35. Fig. XLVIII, XLIX, L, LI. r. nt *to* m l; p. 48. Fig. LXX. l. 18. for *Bevels* r. *Levels*.